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CALIFORNIA BUILDING STANDARDS COMMISSION

CALIFORNIA 2025 ENERGY CODE

CALIFORNIA CODE OF REGULATIONS | TITLE 24 PART 6

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CALIFORNIA ENERGY CODE 2025

CALIFORNIA CODE OF REGULATIONS ▯ TITLE 24 PART 6

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PREFACE

This document is Part 6 of thirteen parts of the official triennial compilation and publication of the adoptions, amendments and repeal of administrative regulations to *California Code of Regulations, Title 24,* also referred to as the *California Building Standards Code.* This part is known as the *California Energy Code.*

The *California Building Standards Code* is published in its entirety every three years by order of the California legislature, with supplements published in intervening years. The California legislature delegated authority to various state agencies, boards, commissions and departments to create building regulations to implement the State's statutes. These building regulations, or standards, have the same force of law, and take effect 180 days after their publication unless otherwise stipulated. The *California Building Standards Code* applies to occupancies in the State of California as annotated.

A city, county, or city and county may establish more restrictive building standards reasonably necessary because of local climatic, geological or topographical conditions. Findings of the local condition(s) and the adopted local building standard(s) must generally be filed with the California Building Standards Commission (or other filing if indicated) to become effective, and may not be effective sooner than the effective date of this edition of the *California Building Standards Code*. Local building standards that were adopted and applicable to previous editions of the *California Building Standards Code* do not apply to this edition without appropriate adoption and the required filing.

Should you find publication (e.g., typographical) errors or inconsistencies in this code or wish to offer comments toward improving its format, please address your comments to:

California Building Standards Commission
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936

Phone: (916) 263-0916
Email: cbsc@dgs.ca.gov

Web page: www.dgs.ca.gov/bsc

ACKNOWLEDGMENTS

The 2025 *California Building Standards Code* (Code) was developed through the outstanding collaborative efforts of the Department of Housing and Community Development, Division of the State Architect, Office of the State Fire Marshal, Department of Health Care Access and Information, California Energy Commission, California Department of Public Health, California State Lands Commission, Board of State and Community Corrections, Department of Water Resources, State Historical Building Safety Board, Department of Consumer Affairs, State Librarian, Department of Food and Agriculture, and the California Building Standards Commission (Commission).

This collaborative effort included the assistance of the Commission's Code Advisory Committees and many other volunteers who worked tirelessly to assist the Commission in the production of this Code.

Governor Gavin Newsom

Members of the California Building Standards Commission

Secretary Amy Tong – Chair
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Erick Mikiten
Aaron Stockwell
Peter Santillan
Laura Rambin
Frank Ramirez
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Juvilyn Alegre
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Stoyan Bumbalov – Executive Director
Kevin Day – Deputy Executive Director

For questions on California state agency amendments, please refer to the contact list on page v.

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CALIFORNIA CODE OF REGULATIONS, TITLE 24

California State Agency Contact List

The following state agencies may propose building standards for buildings, structures and applications under their authority for publication in Title 24. Notice of such proposals may be requested from each agency. See Sections 1.2 through 1.14 of the California Building Code (Part 2, T24) for detailed information on the regulatory authority of most state agencies summarized below. Note [agency acronyms] shown in banners/Matrix Adoption Tables in T24.

Board of State and Community Corrections [BSCC]
bscc.ca.gov — BSCC-Mail@bscc.ca.gov
(916) 445-5073 — *Local Detention Facilities*

Building Standards Commission [BSC, BSC-CG]
dgs.ca.gov/BSC — cbsc@dgs.ca.gov
(916) 263-0916 — *State Buildings including UC & CSU Nonresidential Green Buildings Standards*

Department of Consumer Affairs Boards/Bureaus:

Acupuncture Board [CA]
acupuncture.ca.gov — AcuPolicy@dca.ca.gov
(916) 515-5200 — *Acupuncture Offices*

Board of Pharmacy [CA]
pharmacy.ca.gov
(916) 518-3100 — *Pharmacies*

Board of Barbering and Cosmetology [CA]
barbercosmo.ca.gov — barbercosmo@dca.ca.gov
(916) 574-7570 — *Barber, Cosmetology & Electrolysis Establishments*

Bureau of Household Goods and Services [CA]
bhgs.dca.ca.gov
(916) 999-2041 — *Insulation Testing*

Structural Pest Control Board [CA]
pestboard.ca.gov — pestboard@dca.ca.gov
(800) 737-8188 — *Structural Pest Control Locations*

Veterinary Medical Board [CA]
vmb.ca.gov — vmb@dca.ca.gov
(916) 515-5220 — *Veterinary Facilities*

Department of Food and Agriculture [AGR]
cdfa.ca.gov
(916) 900-5004 — *Rendering & Collection Centers*
(916) 900-5064 — *Meat & Poultry Packing Plants*
(916) 900-5008 — *Milk & Dairy Food Safety*

Department of Health Care Access and Information

Office of Statewide Hospital Planning and Development
[OSHPD 1, 1R, 2, 3, 4, 5, 6]
hcai.ca.gov — regsunit@hcai.ca.gov
(916) 440-8300 — *Hospital Standards, Skilled Nursing Facility Standards & Clinic Standards*

Department of Public Health [DPH]
cdph.ca.gov (Recreational Health)
(916) 449-5661 — *Food Establishments, Organized Camps, Public Swimming Pools*

Department of Housing and Community Development
[HCD 1, 2, 1-AC]
hcd.ca.gov — Title24@hcd.ca.gov
(800) 952-8356
Option 5 > Option 2 — *State Housing Law: including Housing Accessibility, Hotels/Motels, Apartments/Condominiums, Dormitories, Single-Family Dwellings, ADUs, Permanent Structures in Mobile Home Parks*
Option 5 > Option 4 — *Factory-Built Housing*
Option 5 > Option 5 — *Employee Housing*

Department of Water Resources [DWR]
water.ca.gov — DWRwebcomment@water.ca.gov
(916) 653-5791 — *Plumbing for Recycled Water, Floodplain Construction*

Division of the State Architect
dgs.ca.gov/DSA
(916) 445-8100

Access Compliance [DSA-AC]
(916) 445-5827 — DSAaccess@dgs.ca.gov
Access for Persons with Disabilities

Structural Safety [DSA-SS, DSA-SS/CC]
Public Schools & Community Colleges, State Essential Services Buildings

State Historical Building Safety Board [SHBSB]
(916) 445-7627 — shbsb@dgs.ca.gov
Historical Building Rehabilitation, Preservation, Restoration or Relocation

Energy Commission [CEC]
energy.ca.gov — Title24@energy.ca.gov
(800) 772-3300 — *Building Energy Efficiency, Compliance Manual & Compliance Forms*

Office of the State Fire Marshal [SFM]
osfm.fire.ca.gov — codedevelopment@fire.ca.gov
(916) 568-3800 — *Fire & Life Safety*

State Lands Commission [SLC]
slc.ca.gov — MOTEMS.Public@slc.ca.gov
(510) 741-4950 — *Marine Oil Terminals*

State Librarian [SL]
library.ca.gov — csllaw@library.ca.gov
(916) 323-9843 — *Public Library Construction & Renovation*

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HOW TO DETERMINE WHERE CHANGES HAVE BEEN MADE

Symbols in the margins indicate where changes have been made or language has been deleted.

|| This symbol indicates that a change has been made.

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SUBCHAPTER

1 ALL OCCUPANCIES—GENERAL PROVISIONS

SECTION 100.0—SCOPE

(a) **Buildings covered.** The provisions of Part 6 apply to all buildings:

1. That are of Occupancy Group A, B, E, F, H, I, L, M, R, S or U; and
2. For which an application for a building permit or renewal of an existing permit is filed (or is required by law to be filed) on or after the effective date of the provisions, or which are constructed by a governmental agency; and
3. That are:
   A. Unconditioned; or
   B. Indirectly or directly conditioned, or process spaces.

Exception 1 to Section 100.0(a): Qualified historic buildings as regulated by the *California Historic Building Code* (Title 24, Part 8). Lighting in qualified historic buildings shall comply with the applicable requirements in Section 140.6(a)3Q.

Exception 2 to Section 100.0(a): Building departments, at their discretion, may not require compliance for temporary buildings, temporary outdoor lighting or temporary lighting in an unconditioned building, or structures erected in response to a natural disaster. Temporary buildings or structures shall be completely removed upon the expiration of the time limit stated in the permit.

Exception 3 to Section 100.0(a): Buildings in Occupancy Group I-3 and I-4.

(b) **Parts of buildings regulated.** The provisions of Part 6 apply to the building envelope, space-conditioning systems, water-heating systems, pool and spas, solar ready buildings, indoor lighting systems of buildings, outdoor lighting systems, electrical power distribution systems, and signs located either indoors or outdoors, in buildings that are:

1. Covered by Section 100.0(a); and
2. Set forth in Table 100.0-A.

(c) **Habitable stories.**

1. All conditioned space in a story shall comply with Part 6, whether or not the story is a habitable space.
2. All unconditioned space in a story shall comply with the lighting requirements of Part 6, whether or not the story is a habitable space.

(d) **Outdoor lighting and indoor and outdoor signs.** The provisions of Part 6 apply to outdoor lighting systems and to signs located either indoors or outdoors as set forth in Table 100.0-A.

(e) **Sections applicable to particular buildings.** Table 100.0-A and this subsection list the provisions of Part 6 that are applicable to different types of buildings covered by Section 100.0(a).

1. **All buildings.** Sections 100.0 through 110.12 apply to all buildings.

Exception to Section 100.0(e)1: Spaces or requirements not listed in Table 100.0-A.

TABLE 100.0-A—APPLICATION OF STANDARDS

OCCUPANCIES	APPLICATION	MANDATORY	PRESCRIPTIVE	PERFORMANCE	ADDITIONS/ ALTERATIONS
All Buildings	General	100.0, 100.1, 100.2, 110.0	100.0, 100.1, 100.2, 110.0	100.0, 100.1, 100.2, 110.0	100.0, 100.1, 100.2, 110.0
Nonresidential and Hotels/Motels	General	120.0	140.0, 140.2	140.0, 140.1	141.0
	Envelope (conditioned)	110.6, 110.7, 110.8, 120.7	140.3		
	Envelope (unconditioned, process spaces)	N.A.	140.3(c)		
	HVAC (conditioned)	110.2, 110.5, 120.1, 120.2, 120.3, 120.4, 120.5, 120.8, 120.10	140.4		
	Water Heating	110.3, 120.3, 120.8, 120.9	140.5		
	Indoor Lighting (conditioned, process spaces)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6		
	Indoor Lighting (unconditioned and parking garages)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6	N.A.	
	Outdoor Lighting	110.9, 130.0, 130.2, 130.4	140.7		
	Electrical Power Distribution	110.11, 130.5	N.A.		
	Pool and Spa Systems	110.4, 110.5, 150.0(p)			
	Solar Ready Buildings	110.10			141.0(a)
	Solar PV and Battery Energy Storage Systems	N.A.	140.10	140.0, 140.1	N.A.

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TABLE 100.0-A—APPLICATION OF STANDARDS—continued

OCCUPANCIES	APPLICATION	MANDATORY	PRESCRIPTIVE	PERFORMANCE	ADDITIONS/ ALTERATIONS
Covered Processes[1]	Envelope, Ventilation, Process Loads	110.2, 120.3, 120.6	140.9	140.1	110.2, 120.3, 120.6, 140.9, 141.1
Demand Responsive (DR) Controls	DR Control Thermostats	JA5; Exception 5 to Section 110.10(b)1A; Exception 4 to Section 110.10(b)1B	N.A.	N.A.	N.A.
	DR Zonal HVAC Controls	110.12	N.A.	N.A.	N.A.
	DR Lighting Controls	110.12	140.6(a)2K; 170.2(e)2Bxi	N.A.	Table 141.0-F; Table 180.2-E
	DR Electronic Message Center Control	110.12, 130.3(a)3	N.A.	N.A.	N.A.
	DR Controlled Receptacles	110.12, 130.5(e), 160.6(e)	N.A.	N.A.	N.A.
Signs	Indoor and Outdoor	110.9, 130.0, 130.3, 160.5(d)	140.8, 170.2(e)7	N.A.	141.0, 141.0(b)2H, 180.2(b)4Bvi
Single-family	General	150.0	150.1(a), (c)	150.1(a), (b)	150.2(a), (b)
	Envelope (conditioned)	110.6, 110.7, 110.8, 150(a), 150.0(b), 150.0(c), 150.0(d), 150.0(e), 150.0(g), 150.0(q)			
	HVAC (conditioned)	110.2, 110.5, 150.0(h), 150.0(i), 150.0(j), 150.0(m), 150.0(o)			
	Water Heating	110.3, 150.0(j, n)			
	Indoor Lighting (conditioned, unconditioned and parking garages)	110.9, 130.0, 150.0(k)			
	Outdoor Lighting	110.9, 130.0, 150.0(k)			
	Pool and Spa Systems	110.4, 150.0(p)	N.A.	N.A.	
	Solar Ready Buildings	110.10	N.A.	N.A.	N.A.
	Electric Ready	150.0(s), 150.0(t), 150.0(u), 150.0(v)	N.A.	N.A.	N.A.
	Solar PV Systems	N.A.	150.0(c)14	150.1(a), (b)	N.A.
Multifamily	General	160.0	170.2	170.1	180.0
	HVAC (conditioned)	110.6, 110.7, 110.8, 160.1	170.1(a)		
	Ventilation and Indoor Air Quality	160.2	N.A.		
	HVAC (conditioned)	110.2, 110.5, 160.3	170.2(c)		
	Water Heating	110.3, 160.4	170.2(d)		
	Indoor Lighting	110.9, 160.5	170.2(e)		
	Outdoor Lighting	110.9, 160.5	170.2(e)		
	Electrical Power Distribution	110.11, 160.6	N.A.	N.A.	
	Pool and Spa Systems	110.4, 110.5, 160.7			
	Solar Ready Buildings	110.10, 160.8			
	Electric Ready	160.9			N.A.
	Solar PV and Battery Energy Storage Systems	N.A.	170.2(f), (g), (h)	170.1	N.A.

N.A. = Not Applicable

1. Nonresidential and hotel/motel buildings that contain covered processes may conform to the applicable requirements of both occupancy types listed in this table.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

2. **Newly constructed buildings.**

A. **All newly constructed buildings.** Sections 110.0 through 110.12 apply to all newly constructed buildings within the scope of Section 100.0(a). In addition, newly constructed buildings shall meet the requirements of Subsections B, C, D or E, as applicable.

B. **Nonresidential and hotel/motel buildings that are mechanically heated or mechanically cooled.**

i. **Sections applicable.** Sections 120.0 through 140.8 apply to newly constructed nonresidential buildings and hotels/motels that are mechanically heated or mechanically cooled.

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ii. **Compliance approaches.** In order to comply with Part 6, newly constructed nonresidential buildings and hotels/motels that are mechanically heated or mechanically cooled must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 120.0 through 130.5; and

b. Either:

(i) Performance approach: Section 140.1; or

(ii) Prescriptive approach: Sections 140.2 through 140.10.

C. **Unconditioned nonresidential buildings and process space.** Sections 110.9, 110.10, 120.6, 130.0 through 130.5, 140.3(c), 140.6, 140.7 and 140.8 apply to all newly constructed unconditioned buildings and for process spaces within the scope of Section 100.0(a).

D. **Single-family buildings.**

i. **Sections applicable.** Sections 150.0 through 150.1 apply to newly constructed single-family buildings.

ii. **Compliance approaches.** In order to comply with Part 6, newly constructed single-family buildings must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 110.0 through 110.10 and 150.0; and

b. Either:

(i) Performance approach: Sections 150.1(a) and (b); or

(ii) Prescriptive approach: Sections 150.1(a) and (c).

Exception to Section 100.0(e)2Diib: Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year.

E. **Multifamily Buildings**.

i. Sections applicable. Sections 160.0 through 170.2 apply to newly constructed multifamily buildings.

ii. Compliance approaches. In order to comply with Part 6, newly constructed multifamily buildings must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 110.0 through 110.10, and 160.0; and

b. Either:

(i) Performance approach: Section 170.1; or

(ii) Prescriptive approach: Section 170.2(a) through (f).

F. **Covered processes.**

i. Sections applicable. Sections 110.2, 120.3, 120.6, 140.9, and 141.1 apply to covered processes.

ii. Compliance approaches. In order to comply with Part 6, covered processes must meet the requirements of:

a. The applicable mandatory measures in Sections 110.2, 120.3 and 120.6; and

b. Either:

(i) The performance approach requirements of Section 140.1; or

(ii) The prescriptive approach requirements of Section 140.9.

3. **New construction in existing buildings (additions, alterations and repairs).**

A. **Nonresidential and hotel/motel buildings.** Section 141.0 applies to new construction in existing nonresidential, high-rise residential and hotel/motel buildings. New construction in existing buildings includes additions, alterations and repairs. Section 141.0 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specify which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 141.0 apply to the occupancy after the alterations.

B. **Single-family buildings.** Section 150.2 applies to new construction in existing single-family buildings. New construction in existing buildings includes additions, alterations and repairs. Section 150.2 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specifies which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 150.2 apply to the occupancy after the alterations.

C. **Multifamily buildings.** Section 180.0 applies to new construction in existing multifamily buildings. New construction in existing buildings includes additions, alterations and repairs. Section 180.0 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specifies which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 180.0 apply to the occupancy after the alterations.

4. **Installation of insulation in existing buildings.** Section 110.8(d) applies to buildings in which insulation is being installed in existing attics, or on existing water heaters or existing space conditioning ducts.

5. **Outdoor lighting.** Sections 110.9, 130.0, 130.2, 130.4, 140.7, and 150.0 apply to newly constructed outdoor lighting systems, and Section 141.0 applies to outdoor lighting that is either added or altered.

6. **Signs.** Sections 130.0, 130.3 and 140.8 apply to newly constructed signs located either indoors or outdoors, and Section 141.0 applies to sign alterations located either indoors or outdoors.

(f) **Mixed occupancy.** When a building is designed and constructed for more than one type of occupancy (residential and nonresidential), the space for each occupancy shall meet the provisions of Part 6 applicable to that occupancy.

Exception 1 to Section 100.0(f): If one occupancy constitutes at least 80 percent of the conditioned floor area of the building, the entire building envelope, HVAC and water heating may be designed to comply with the provisions of Part 6 applicable to that occupancy, provided that the applicable lighting requirements in Sections 140.6 through 140.8, 150.0(k), or 160.5 and 170.2(e) are met for each occupancy and space, and mandatory measures in Sections 110.0 through 130.5, 150.0, and 160.0 through 160.9 are met for each occupancy and space.

Exception 2 to Section 100.0(f): If one occupancy constitutes at least 90 percent of the combined conditioned plus unconditioned floor area of the building, the entire building indoor lighting may be designed to comply with only the lighting provisions of Part 6 applicable to that occupancy.

(g) **Administrative requirements.** Administrative requirements relating to permit requirements, enforcement by the Commission, locally adopted energy standards, interpretations, claims of exemption, approved calculation methods, rights of appeal, and certification and labeling requirements of fenestration products and roofing products are specified in California Code of Regulations, Title 24, Part 1, Sections 10-101 to 10-114.

(h) **Certification requirements for manufactured equipment, products and devices.** Part 6 limits the installation of manufactured equipment, products and devices to those that have been certified as specified by Sections 110.0 and 110.1. Requirements for manufactured equipment, products, and devices, when not specified in Title 24 Part 6, are specified in California Code of Regulations, Title 20, Sections 1601–1609.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code*.

SECTION 100.1—DEFINITIONS AND RULES OF CONSTRUCTION

(a) **Rules of Construction.**

1. Where the context requires, the singular includes the plural and the plural includes the singular.
2. The use of "and" in a conjunctive provision means that all elements in the provision must be complied with or must exist to make the provision applicable. Where compliance with one or more elements suffices, or where existence of one or more elements makes the provision applicable, "or" (rather than "and/or") is used.
3. "Shall" is mandatory and "may" is permissive.

(b) **Definitions.** Terms, phrases, words and their derivatives in Part 6 shall be defined as specified in Section 100.1. Terms, phrases, words and their derivatives not found in Section 100.1 shall be defined as specified in the "Definitions" chapters of Title 24, Parts 1 through 5 of the California Code of Regulations. Where terms, phrases, words and their derivatives are not defined in any of the references above, they shall be defined as specified in *Webster's Third New International Dictionary of the English Language, Unabridged* (1961 edition, through the 2002 addenda), unless the context requires otherwise.

AAMA/WDMA/CSA 101/I.S.2/A440-17 are the American Architectural Manufacturers Association/Window and Door Manufacturers Association/Canadian Standards Association document titled "North American Fenestration Standard/Specification for windows, doors, and skylights" (2017).

ACCA is the Air Conditioning Contractors of America.

ACCA MANUAL J is the Air Conditioning Contractors of America document titled "Manual J-Residential Load Calculation," (ANSI/ACCA 2 Manual J – 2016).

ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE is a description of test procedures in the Reference Nonresidential Appendices that includes equipment and systems to be tested, functions to be tested, conditions under which the test shall be performed, the scope of the tests, results to be obtained and measurable criteria for acceptable performance.

ACCESSIBLE is having access thereto, but which first may require removal or opening of access panels, doors or similar obstructions.

ADDITION is any change to a building that increases conditioned floor area and conditioned volume. See also, "newly conditioned space." Addition is also any change that increases the floor area and volume of an unconditioned building of an occupancy group or type regulated by Part 6. Addition is also any change that increases the illuminated area of an outdoor lighting application regulated by Part 6.

ADIABATIC PAD is a material located before the heat transfer surface of an adiabatic condenser, which precools the ambient air by becoming fully wetted during precool mode operation.

AGRICULTURAL BUILDING is a structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. It is not a structure that is a place of human habitation, a place of employment where agricultural products are processed, treated or packaged, or a place used by the public.

AHAM is the Association of Home Appliance Manufacturers.

AHAM HRH-2 is the Association of Home Appliance Manufacturers document titled "Residential Kitchen Range Hood Performance Test Procedures," 2020 (AHAM HRH-2).

AHAM RKRH-CPPG is the Association of Home Appliance Manufacturers document titled "Residential Kitchen Range Hood Certification Program Procedural Guide," 2020 (version 3).

AHRI is the Air-Conditioning, Heating and Refrigeration Institute.

AHRI 210/240 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment," 2023 (AHRI Standard 210/240-2023).

AHRI 310/380 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-17)," 2004 (AHRI 310/380-2017).

AHRI 340/360 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment," 2019 (AHRI Standard 340/360 (I-P)-2019).

AHRI 365 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units," 2009 (ANSI/AHRI Standard 365 (I-P)-2009).

AHRI 400 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Liquid to Liquid Heat Exchangers," 2015 (ANSI/AHRI Standard 400 (I-P)-2015).

AHRI 420 is the Air-Conditioning, Heating, And Refrigeration Institute document titled "2023 Standard for Performance Rating of Forced-Circulation Free-Delivery Unit Coolers," 2023 (AHRI Standard 420-2023 (I-P)).

AHRI 430 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Central Station Air-handling Unit Supply Fans," 2020 (AHRI Standard 430 (I-P)-2020).

AHRI 440 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Fan-coil Units," 2019 (AHRI Standard 440 (I-P)-2019).

AHRI 460 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers," 2005 (ANSI/AHRI Standard 460-2005).

AHRI 540 is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Performance Rating of Positive Displacement Refrigerant Compressors and Compressor Units," 2020 (AHRI Standard 540-2020).

AHRI 550/590 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Water Chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle," 2020 (AHRI Standard 550/590 (I-P)-2020).

AHRI 560 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Absorption Water Chilling and Water Heating Packages," 2000 (AHRI Standard 560-2000).

AHRI 680 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Residential Air Filter Equipment," 2017 (AHRI Standard 680-2017).

AHRI 920 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units," 2020 (AHRI Standard 920 (I-P)-2020).

AHRI 1060 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment," 2018 (AHRI Standard 1060 (I-P)-2018).

AHRI 1230 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment," 2014 (AHRI Standard 1230-2014) with Addendum 1.

AHRI 1240 is the Air-Conditioning, Heating, and Refrigeration Institute document titled "2017 (R2023) Standard for Performance Rating of Active Chilled Beams," 2023 (AHRI Standard 1240-2017 (R2023) (I-P)).

AHRI 1250 is the Air-Conditioning, Heating, and Refrigeration Institute document titled "2020 Standard for Performance Rating of Walk-in Coolers and Freezers," 2020 (AHRI Standard 1250-2020).

AHRI 1360 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Computer and Data Processing Room Air Conditioners," 2017 (AHRI Standard 1360 (I-P)-2017).

AIR, AVAILABLE TRANSFER is that portion of total outdoor ventilation air that is not required to satisfy other exhaust needs or to maintain pressurization of other spaces and that is transferable according to Section 120.1(g).

AIR, INFILTRATION is outdoor air that enters a building or space through openings in the building or space envelope due to negative pressure in the space or building relative to the exterior of the building envelope.

AIR, MAKEUP, or COMPENSATING OUTDOOR AIR is outdoor air that is intentionally conveyed by openings or ducts into the building from the outside; is supplied to the vicinity of an exhaust hood; and replaces air, vapor and contaminants being exhausted by the exhaust hood. Makeup air is generally filtered and fan-forced, and it may be heated or cooled. Makeup air may be delivered through openings or ducts integral to the exhaust hood.

AIR, REPLACEMENT is air that is used to replace air removed from a building through an exhaust system. Replacement air may be derived from one or more of the following: makeup air, portions of supply air, transfer air, or infiltration air.

AIR, SUPPLY is air entering a space from an air-conditioning, heating, or ventilating system for the purpose of comfort conditioning. Supply air is generally filtered, fan-forced, and heated, cooled, humidified or dehumidified as necessary to maintain specified temperature and humidity conditions.

AIR, TRANSFER is air transferred, whether actively by fans or passively by pressure differentials, from one room to another within a building through openings in the room envelope.

AIR BARRIER is a combination of interconnected materials and assemblies joined and sealed together to provide a continuous barrier to air leakage through the building envelope that separates conditioned from unconditioned space, or that separates adjoining conditioned spaces of different occupancies or uses.

AIR CONDITIONER is an appliance that supplies cooled and dehumidified air to a space for the purpose of cooling objects within the space.

AIR CURTAIN UNIT means equipment providing a directionally controlled stream of air moving across the entire height and width of an opening that reduces the infiltration or transfer of air from one side of the opening.

AIR FILTER, AIR FILTER EQUIPMENT, or **AIR FILTER DEVICE** is air-cleaning equipment used for removing particulate matter from the air.

AIR FILTER MEDIA is the part of the air filter equipment which is the actual particulate removing agent.

AIR-COOLED AIR CONDITIONER is an air conditioner using an air-cooled condenser.

AIR-HANDLING UNIT or **AIR HANDLER** is a blower or fan that distributes supply air to a room, space or area.

AIR-SOURCE HEAT PUMP is an appliance that consists of one or more factory-made assemblies that includes an indoor conditioning coil, a compressor and a refrigerant-to-air heat exchanger, and that provides heating and cooling functions.

AIR-TO-AIR HEAT EXCHANGER is a device which will reduce the heat losses or gains that occur when a building is mechanically ventilated, by transferring heat between the conditioned air being exhausted and outside air being supplied.

AIR-TO-WATER HEAT PUMP (AWHP) is a factory-made packaged heat pump system containing one or more compressors and heat exchangers for transferring heat between refrigerant and air, as well as between refrigerant and water, and various other components. Its primary purpose is to generate heated or cooled water to meet space conditioning loads, domestic hot water loads, or both.

ALTERATION is any change to a building's water-heating system, space-conditioning system, lighting system, electrical power distribution system, or envelope that is not an addition. Alteration is also any change that is regulated by Part 6 to an outdoor lighting system that is not an addition. Alteration is also any change that is regulated by Part 6 to signs located either indoors or outdoors. Alteration is also any change that is regulated by Part 6 to a covered process that is not an addition. (See also "fenestration alteration.")

ALTERED COMPONENT is a component that has undergone an alteration.

ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (AC-OUTPUT UPS) is a combination of converters, switches and energy storage devices, such as batteries, constituting a power system for maintaining continuity of load power in case of input power failure. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the uninterruptible power supply. An AC-output UPS is an uninterruptible power supply that supplies power with a continuous flow of electric charge that periodically reverses direction.

ALTERNATIVE CALCULATION METHODS (ACM) are compliance software, or alternative component packages, or exceptional methods approved by the Commission under Section 10-109. ACMs are also referred to as Compliance Software.

AMCA is the Air Movement and Control Association.

ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE) is a measure of the percentage of heat from the combustion of gas or oil which is transferred to the space being heated during a year, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

ANNUNCIATED is a type of visual signaling device that indicates the on, off, or other status of a load.

ANSI is the American National Standards Institute.

ANSI/AMCA 220 is the Air Movement and Control Association document titled "Laboratory Methods for Testing Air Curtain Units for Aerodynamic Performance Rating," 2021 (ANSI/AMCA 220-21).

ANSI/AHRI 390 is the Air-Conditioning, Heating and Refrigeration Institute document titled "Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps," 2003 (ANSI/AHRI Standard 390 (I-P)-2003).

ANSI/AMCA 208 is the Air Movement and Control Association document titled "Calculation of the Fan Energy Index," 2018 (ANSI/AMCA 208-18).

ANSI/AMCA 210 is the Air Movement and Control Association document titled "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating," 2016 (ANSI/AMCA 210-16).

ANSI/AMCA STANDARD 500-D is the American National Standards Institute / Air Movement and Control Association document titled "Laboratory Methods of Testing Dampers for Rating," 2018 (ANSI/AMCA 500-D-2018).

ANSI/ASABE S640 is the American National Standards Institute/American Society of Agricultural and Biological Engineers document titled "Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)," 2017 (ANSI/ASABE S640 JUL2017).

ANSI/ASSPE Z9.5 is the American National Standards Institute document titled "Laboratory Ventilation," 2012 (ANSI/AIHA/ASSPE Z9.5-2012).

ANSI C82.6 is the American National Standards Institute document titled "AMERICAN NATIONAL STANDARD FOR LAMP BALLASTS—Ballasts for High-Intensity Discharge Lamps—Methods of Measurement," 2020 (ANSI C82.6-2015 (R2020)).

ANSI/CTA-2045-B is the American National Standards Institute document titled "Modular Communications Interface for Energy Management," 2021 (ANSI/CTA-2045-B-2021).

ANSI/NEMA WD 6 is the National Electrical Manufacturers Association Document titled "American National Standard for Wiring Devices—Dimensional Specification," 2016 (ANSI/NEMA WD 6-2016).

ANSI Z21.40.4a is the American National Standards Institute document titled "Performance Testing and Rating of Gas-Fired, Air Conditioning and Heat Pump Appliances," 2017 (ANSI Z21.40.4a-1996 (R2017)/CGA 2.94a-M96 (R2017)).

ANSI Z21.47 is the American National Standards Institute document titled "Gas-Fired Central Furnaces," 2021 (ANSI Z21.47-2021/CSA 2.3-2021).

ANSI Z83.8 is the American National Standards Institute document titled "Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces," 2016 (ANSI Z83.8-2016/CSA 2.6-2016 (R2021)).

APPLIANCE EFFICIENCY REGULATIONS are the regulations in Title 20, Sections 1601 et seq. of the California Code of Regulations.

APPROVED CALCULATION METHOD (See "alternative calculation methods.")

ASCE 7-16 is the American Society of Civil Engineers Standard 7-16.

ASHRAE is the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

ASHRAE CLIMATIC DATA FOR REGION X is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Climatic Data for Region X, Arizona, California, Hawaii and Nevada," Publication SPCDX, 1982 and "Supplement," 1994.

ASHRAE HANDBOOK, APPLICATIONS VOLUME is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Applications" (I-P) (2019).

ASHRAE HANDBOOK, FUNDAMENTALS VOLUME is the American Society of Heating, Refrigerating and Air- Conditioning Engineers document titled "ASHRAE Handbook: Fundamentals" (I-P) (2017).

ASHRAE HANDBOOK, SYSTEMS AND EQUIPMENT VOLUME is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Systems and Equipment" (I-P) (2020).

ASHRAE GUIDELINE 36 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "High-Performance Sequences of Operation for HVAC Systems," 2021 (ASHRAE Guideline 36-2021).

ASHRAE STANDARD 52.2 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size," 2017 (ANSI/ASHRAE Standard 52.2-2017).

ASHRAE STANDARD 55 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Thermal Environmental Conditions for Human Occupancy," 2020 (ANSI/ASHRAE Standard 55-2020).

ASHRAE STANDARD 62.1 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled **"**Ventilation for Acceptable Indoor Air Quality," 2019 (ANSI/ASHRAE Standard 62.1-2022, including Addenda y, ao, P, B).

ASHRAE STANDARD 62.2 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Ventilation and Acceptable Indoor Air Quality in Residential Buildings," 2022 (ANSI/ASHRAE Standard 62.2-2022).

ASHRAE STANDARD 84 is the American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Method of Testing Air-to-Air Heat/Energy Exchangers," 2020 (ANSI/ASHRAE 84-2020).

ASHRAE STANDARD 90.1 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Energy Standards for Buildings Except Low-Rise Residential Buildings," 2019 (ANSI/ASHRAE/IES Standards 90.1-2019).

ASHRAE STANDARD 154 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Ventilation for Commercial Cooking Operations," 2016 (ANSI/ASHRAE Standard 154-2016).

ASHRAE STANDARD 193 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Method of Test for Determining the Airtightness of HVAC Equipment," RA2014 (ANSI/ASHRAE Standard 193-RA2014).

ASME is the American Society of Mechanical Engineers.

ASME A17.1/CSA B44 is the American Society of Mechanical Engineers document titled "Safety Code for Elevators and Escalators," 2019 (ASME A17.1-2019/CSA B44-2019).

ASME A112.18.1/CSA B125.1 is the American Society of Mechanical Engineers document titled "Plumbing Supply Fittings," 2018 (ASME A112.18.1-2018/CSA B125.1-18).

ASTM is the American Society for Testing and Materials International.

ASTM C55 is the American Society for Testing and Materials document titled "Standard Specifications for Concrete Building Brick," 2017 (ASTM C55-17).

ASTM C177 is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus," 2019 (ASTM C177-19).

ASTM C272 is the American Society for Testing and Materials document titled "Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions," 2018 (ASTM C272/C272M-18).

ASTM C335/C335M is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation," 2017 (ASTM C335/C335M-17).

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ASTM C518 is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus," 2017 (ASTM C518-17).

ASTM C731 is the American Society for Testing and Materials document titled "Standard Test Method for Extrudability, After Package Aging of Latex Sealants," 2015 (ASTM C731-15).

ASTM C732 is the American Society for Testing and Materials document titled "Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants," 2017 (ASTM C732-17).

ASTM C836 is the American Society for Testing and Materials document titled "Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course," 2018 (ASTM C836/C836M-18).

ASTM C1167 is the American Society for Testing and Materials document titled "Standard Specification for Clay Roof Tiles," 2017 (ASTM C1167-11(2017)).

ASTM C1371 is the American Society for Testing and Materials document titled "Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers," 2015 (ASTM C1371-15).

ASTM C1492 is the American Society for Testing and Materials document entitled "Standard Specification for Concrete Roof Tile," 2016 [ASTM C1492-03 (2016)].

ASTM C1549 is the American Society for Testing and Materials document entitled "Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer," 2016 (ASTM C1549- 16).

ASTM C1583 is the American Society for Testing and Materials document titled "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)," 2020 (ASTM C1583/C1583M-20).

ASTM D448 is the American Society for Testing and Materials document titled "Standard Classification for Sizes of Aggregate for Road and Bridge Construction," 2017 [ASTM D448-12(2017)].

ASTM D522 is the American Society for Testing and Materials document titled "Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings," 2017 (ASTM D522/D522M-17).

ASTM D822 is the American Society for Testing and Materials document titled "Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings," 2018 (ASTM D822/D822M-13(2018)).

ASTM D1003 is the American Society for Testing and Materials document titled "Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics," 2021 (ANSI/ASTM D1003-21).

ASTM D1653 is the American Society for Testing and Materials document titled "Standard Test Methods for Water Vapor Transmission of Organic Coating Films," 2021 (ASTM D1653-21).

ASTM D1863 is the American Society for Testing and Materials document titled "Standard Specification for Mineral Aggregate Used on Built-Up Roofs," 2018 [ASTM D1863/D1863M-05 (2018)].

ASTM D2202 is the American Society for Testing and Materials document titled "Standard Test Method for Slump of Sealants," 2019 (ASTM D2202-00(2019).

ASTM D2370 is the American Society for Testing and Materials document titled "Standard Test Method for Tensile Properties of Organic Coatings," 2016 (ASTM D2370-98-16).

ASTM D2824 is the American Society for Testing and Materials document titled "Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, and Fibered without Asbestos," 2018 (ASTM D2824/D2824M-18).

ASTM D3468 is the American Society for Testing and Materials document titled "Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing," 2020 [ASTM D3468/D3468M-99 (2020)].

ASTM D3805 is the American Society for Testing and Materials document titled "Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings," 2016 (ASTM D3805/D3805M-16).

ASTM D4798 is the American Society for Testing and Materials document titled "Standard Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)," 2021 [ASTM D4798/D4798M-11(2021)].

ASTM D5870 is the American Society for Testing and Materials document titled "Standard Practice for Calculating Property Retention Index of Plastics," 2016 (ASTM D5870-16).

ASTM D6083 is the American Society for Testing and Materials document titled "Standard Specification for Liquid Applied Acrylic Coatings Used in Roofing," 2021 (ASTM D6083/D6083M-21).

ASTM D6694 is the American Society for Testing and Materials document titled "Standard Specification for Liquid-Applied Silicone Coating Used in Spray Polyurethane Foam Roofing Systems," 2015 (ASTM D6694/D6694M-15).

ASTM E96 is the American Society for Testing and Materials document titled "Standard Test Methods for Water Vapor Transmission of Materials," 2016 (ASTM E96/E96M-16).

ASTM E283 is the American Society for Testing and Materials document titled "Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylight, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," 2019 (ASTM E283/E238-19).

ASTM E408 is the American Society for Testing and Materials document titled "Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques," 2019 [ASTM E408-13 (2019)].

ASTM E779 is the American Society for Testing and Materials document titled "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization," 2019 (ASTM E779-19).

ASTM E903 is the American Society for Testing and Materials document titled "Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres," 2020 (ASTM E903-20).

ASTM E972 is the American Society for Testing and Materials document titled "Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight," 2021 [ASTM E972-96 (2021)].

ASTM E1175 is the American Society for Testing and Materials document titled "Standard Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere," 2015 [ASTM E1175-87(2015)].

ASTM E1677 is the American Society for Testing and Materials document titled "Standard Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls," 2019 (ASTM E1677-19).

ASTM E1680 is the American Society for Testing and Materials document titled "Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems," 2016 (ASTM E1680-16).

ASTM E1918 is the American Society for Testing and Materials document entitled "Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field," 2016 (ASTM E1918-16).

ASTM E1980 is the American Society for Testing and Materials document titled "Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surface," 2019 [ASTM E1980-11 (2019)].

ASTM E2178 is the American Society for Testing and Materials document titled "Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials," 2021 (ASTM E21778-21).

ASTM E2357 is the American Society for Testing and Materials document titled "Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies," 2018 (ASTM E2357-18).

ASTM E3087 is the American Society for Testing and Materials document titled "Standard Test Method for Measuring Capture Efficiency of Domestic Range Hoods," 2018 (ASTM E3087-18).

ATTIC is an enclosed space directly below the roof deck and above the ceiling beams.

AUTOMATED TELLER MACHINE (ATM) is any electronic information processing device which accepts or dispenses currency in connection with a credit, deposit or convenience account without involvement by a clerk.

AUTOMATIC is capable of operating without human intervention.

AZIMUTH is the degrees of clockwise rotation from true north.

BACK-UP COMPRESSORS are those compressors not used to meet peak compressed air loads. Back-up compressors are physically connected to the compressed air piping system and can be automatically controlled to turn on if one of the online compressors fails. Back-up compressors do not normally operate.

BATTERY ENERGY STORAGE SYSTEM (BESS) is stationary equipment that receives electrical energy and then utilizes batteries to store that energy for later use to supply electrical energy when needed. The BESS consists of one or more modules, a power conditioning system, and balance of plant components.

BELOW-GRADE WALL is the portion of a wall, enclosing conditioned space, that is below the grade line.

BESS READY INTERCONNECTION EQUIPMENT is equipment, including but not limited to a battery energy storage system (BESS) ready panelboard or switchboard, that can accommodate the connection of a distributed energy resource or a BESS capable of either automatic or manual isolation from the utility power source.

BESS READY PANELBOARD/SWITCHBOARD is a panelboard or switchboard that can accommodate either automatic or manual switching between a utility power source to a distributed energy resource or a BESS, such as a split bus panelboard or a switchboard.

BOILER SYSTEM is one or more boilers and their piping and controls that work together to supply steam or hot water to heat output devices remote from the boiler.

BUBBLE POINT is the liquid saturation temperature of a refrigerant at a specified pressure.

BUILDING is any structure or space covered by Section 100.0 of the Building Energy Efficiency Standards.

BUILDING COMMISSIONING is a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements.

BUILDING ENVELOPE is the ensemble of exterior and demising partitions of a building that enclose conditioned space.

CALL CENTER is a phone center that handles large number of phone calls including but not limited to help desk, customer and sales support, technical support, emergency response, telephone answering service, and inbound and outbound telemarketing.

CARBON DIOXIDE ENRICHMENT is injection of additional carbon dioxide into controlled environment horticulture spaces for the purpose of stimulating plant growth.

CASCADE REFRIGERATION SYSTEM is a type of refrigeration system that uses a low-stage refrigeration system where the heat rejected from condensing the low-stage refrigerant is absorbed using a heat-exchanger by a separate high-stage refrigeration system, and the ultimate heat rejection to ambient air is accomplished by the high-stage refrigeration system.

CATHEDRAL CEILING is an exterior partition with a slope less than 60 degrees from horizontal that is created by applying the ceiling directly to the underside of the roof framing members and applying structural roof sheathing directly to the top of the roof framing members/rafters. It may be flat or sloped and vented or unvented.

CEILING FAN means a nonportable device that is suspended from a ceiling or overhead structure for circulating air via the rotation of fan blades as defined in 10 CFR 430.2.

CENTRAL FAN VENTILATION COOLING SYSTEM (CFVCS) is a ducting arrangement including outside air ducts, motorized dampers and an automatic control system that allows a residential space-conditioning system central fan and ducts to distribute outside air throughout a residential dwelling unit, intending to reduce or eliminate the need for mechanical cooling.

CERTIFIED TO THE ENERGY COMMISSION means, when used in association with appliances, certified under Section 1606 of Title 20 of the California Code of Regulations; and otherwise means certified by the manufacturer in a declaration, executed under penalty of perjury under the laws of the State of California, that all the information provided pursuant to the certification is true, complete, accurate and in compliance with all applicable provisions of Part 6; and if applicable that the equipment, product or device was tested under the applicable test method specified in Part 6.

CERTIFYING ORGANIZATION is an independent organization recognized by the Commission to certify manufactured devices for performance values in accordance with procedures adopted by the Commission.

CIE 13.3 is the International Commission on Illumination (Commission Internationale de l'Eclairage) document titled "Method of Measuring and Specifying Colour Rendering Properties of Light Sources," 1995 (CIE 13.3-1995).

CIE 15 is the International Commission on Illumination (Commission Internationale de l'Eclairage) document titled "Technical Report: Colorimetry," 2018 (CIE 15:2018).

CIRCULATING FAN means a fan that is not a ceiling fan, but that is used to move air within a space that has no provision for connection to ducting or separation of the fan inlet from its outlet, and designed to be used for the general circulation of air.

CLIMATE ZONES are the 16 geographic areas of California for which the commission has established typical weather data, prescriptive packages and energy budgets. Climate zones are defined by ZIP code and listed in Reference Joint Appendix JA2. FIGURE 100.1-A is an approximate map of the 16 climate zones.

CLOSED-CIRCUIT COOLING TOWER is a cooling tower that utilizes indirect contact between a heated fluid, typically water or glycol, and the cooling atmosphere to transfer the source heat load through sensible heat, latent heat and mass transfer indirectly to the air, essentially combining a heat exchanger and cooling tower into an integrated and relatively compact device.

CODES, CALIFORNIA HISTORICAL BUILDING CODE is the *California Historical Building Code*, California Code of Regulations, Title 24, Part 8 and Part 2 (Chapter 34).

CODES, CBC is the *2025 California Building Code.*

CODES, CEC is the *2025 California Electrical Code.*

CODES, CFC is the *2025 California Fire Code.*

CODES, CMC is the *2025 California Mechanical Code.*

CODES, CPC is the *2025 California Plumbing Code.*

COEFFICIENT OF PERFORMANCE (COP), COOLING is the ratio of the rate of net heat removal to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

COEFFICIENT OF PERFORMANCE (COP), HEATING is the ratio of the rate of net heat output to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

COEFFICIENT OF PERFORMANCE (COP), HEAT PUMP is the ratio of the rate of useful heat output delivered by the complete heat pump unit (exclusive of supplementary heating) to the corresponding rate of energy input, in consistent units and as determined using the applicable test method in Appliance Efficiency Regulations or Section 110.2.

COMBINED ENERGY EFFICIENCY RATIO (CEER) is the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy input (in watts) of a cooling system under designated operating conditions, including standby mode, as determined using the applicable test method in the Appliance Efficiency Regulations.

COMBUSTION AIR POSITIVE SHUT-OFF is a means of restricting air flow through a boiler combustion chamber during standby periods, used to reduce standby heat loss. A flue damper and a vent damper are two examples of combustion air positive shut-off devices.

COMBUSTION EFFICIENCY is a measure of the percentage of heat from the combustion of gas or oil that is transferred to the medium being heated or lost as jacket loss.

COMMERCIAL BOILER is a type of boiler with a capacity (rated maximum input) of 300,000 Btus per hour (Btu/h) or more and serving a space heating or water heating load in a commercial building.

COMMISSION is the California State Energy Resources Conservation and Development Commission, which is also referred to as the California Energy Commission.

COMPARTMENTALIZATION is when a dwelling unit enclosure area, including walls, ceilings, and floors shared with exterior spaces or adjacent spaces in the building, including but not limited to neighboring units, corridors, and elevator shafts, is constructed to prevent air leakage.

COMPLEX MECHANICAL SYSTEMS are systems that include 1) fan systems each serving multiple thermostatically controlled zones; or 2) built-up air handler systems (nonunitary or nonpackaged HVAC equipment); or 3) hydronic or steam heating systems; or 4) hydronic cooling systems. Complex mechanical systems are NOT the following: (1) unitary or packaged equipment listed in Table 110.2-A, 110.2-B, 110.2-C or 110.2-E that each serves one zone, or (2) two-pipe, heating only systems serving one or more zones.

COMPLIANCE SOFTWARE is software that has been approved pursuant to Section 10-109 of Part 1 of Title 24 of the California Code of Regulations, to demonstrate compliance with the performance approach of Part 6.

COMPRESSED AIR SYSTEM is a system of at least one compressor providing compressed air at 40 psig or higher.

COMPUTER ROOM is a room within a building whose primary function is to house electronic equipment and that has a design information technology equipment (ITE) equipment power density exceeding 20 watts/ft^2 (215 watts/m^2) of conditioned floor area.

CONDENSER is a refrigeration component that condenses refrigerant vapor by rejecting heat to air mechanically circulated over its heat transfer surface.

CONDENSER, ADIABATIC is a condenser that has the ability to use two heat transfer processes in series as accomplished by a single factory-made unit. The first heat transfer process is the precooling of the entering air by lowering the entering air drybulb temperature. The second heat transfer process is forced-air circulation cooling over the heat transfer surface of the condenser.

DRY MODE is an operating condition of an adiabatic condenser wherein the only means of heat transfer is accomplished through forced-air circulation over the heat transfer surface of the condenser without any precooling of the entering air.

PRECOOL MODE is an operating condition of an adiabatic condenser wherein the entering air is precooled.

CONDENSER SPECIFIC EFFICIENCY is the full load condenser Total Heat of Rejection (THR) capacity at standardized conditions divided by the fan input electric power (including but not limited to spray pump electric input power for evaporative condensers) at 100 percent rated fan speed.

CONDITIONED FLOOR AREA (CFA) is the floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space.

CONDITIONED GREENHOUSE is a greenhouse that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft^2, or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft^2.

CONDITIONED SPACE is an enclosed space within a building that is directly conditioned or indirectly conditioned.

CONDITIONED SPACE, DIRECTLY is an enclosed space that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft^2) or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft^2. Directly conditioned space does not include process space. (See "process space.")

CONDITIONED SPACE, INDIRECTLY is enclosed space that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have fixed vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

CONDITIONED VOLUME is the total volume (in cubic feet) of the conditioned space within a building.

CONTINUOUS INSULATION (c.i.) is insulation that is continuous across all assemblies that separate conditioned from unconditioned space. It is installed on the exterior or interior or is integral to any opaque surface of the building envelope and has no thermal bridges other than fasteners and necessary service openings.

CONTROLLED ATMOSPHERE is an airtight space maintained at reduced oxygen levels for the purpose of reducing respiration of perishable product in long-term storage.

CONTROLLED ENVIRONMENT HORTICULTURE (CEH) SPACE is a building space dedicated to plant production by manipulating indoor environmental conditions, such as through electric lighting, irrigation, mechanical heating, mechanical cooling or dehumidification. CEH space does not include building space where plants are grown solely to decorate that same space.

COOLER is a space to be capable of operation at a temperature greater than or equal to 28°F but less than 55°F.

COOL ROOF is a roofing material with high thermal emittance and high solar reflectance, or low thermal emittance and exceptionally high solar reflectance as specified in Part 6 that reduces heat gain through the roof.

COOLING EQUIPMENT is equipment used to provide mechanical cooling for a room or rooms in a building.

CRAWL SPACE is a space immediately under the first floor of a building adjacent to grade.

CRRC-1 is the Cool Roof Rating Council document entitled "Product Rating Program Manual" (2021).

CTI is the Cooling Technology Institute.

CTI ATC-105 is the Cooling Technology Institute document titled "Acceptance Test Code for Cooling Towers," 2019 (CTI ATC-105-19).

CTI ATC-105DS is the Cooling Technology Institute document titled "Acceptance Test Code for Dry Fluid Coolers," 2018 [CTI ATC-105DS (18)].

CTI ATC-105S(11) is the Cooling Technology Institute document titled "Acceptance Test Code for Closed-Circuit Cooling Towers," 2011 (CTI ATC-105-11).

CTI ATC-106 is the Cooling Technology Institute document titled "Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers," 2011 [CTI ATC-106 (11)].

CTI STD-201 is the Cooling Technology Institute document titled "Standard for the Certification of Water Cooling Thermal Performance," 2017 [CTI STD-201-RS(17)].

CURRENT AIR DEMAND is the actual cubic feet per minute (acfm) of total air flow necessary for end uses in a compressed air system.

C-VALUE (also known as C-factor) is the time rate of heat flow through unit area of a body induced by a unit temperature difference between the body surfaces, in Btu ($hr \times ft^2 \times °F$). It is not the same as K-value or K-factor.

CYCLES OF CONCENTRATION is the number of times the concentration of total dissolved solids (TDS) in cooling tower water is multiplied relative to the TDS in the makeup water. Because evaporation of pure water leaves dissolved solids behind in the system water, TDS increases over time as the tower operates. The number of times the dissolved minerals are concentrated is relative to the TDS in the makeup water. For example, five cycles of concentration represents five times the concentration of solids in the cooling tower system water relative to the TDS in the makeup water entering the tower.

DATA CENTER is a building whose primary function is to house computer room(s).

DAYLIT ZONE is the floor area under skylights or next to windows. Types of daylit zones includes primary sidelit daylit zone, secondary sidelit daylit zone, and skylit daylit zone.

DEADBAND is the temperature range within which the HVAC system is neither calling for heating or cooling.

DECORATIVE GAS APPLIANCE is a gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace.

DEDICATED OUTDOOR AIR SYSTEM (DOAS) is a ventilation system that delivers 100 percent outdoor air and delivers ventilation supply air to each space, either directly or in conjunction with local or central space-conditioning systems serving those same spaces such as a DX-DOAS, HRV, ERV or custom ventilation-only unit.

DEGREE DAY, HEATING is a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F. The number of degree days for specific geographical locations are those listed in the Reference Joint Appendix JA2. For those localities not listed in the Reference Joint Appendix JA2, the number of degree days is as determined by the applicable enforcing agency.

DEHUMIDIFIER is a product other than a portable air conditioner, room air conditioner or packaged terminal air conditioner that is a self-contained, electrically operated and mechanically encased assembly consisting of 1) a refrigerated surface (evaporator) that condenses moisture from the atmosphere, 2) a refrigerating system, including an electric motor, 3) an air-circulating fan and 4) a means for collecting or disposing of the condensate.

DEMAND FLEXIBILITY MEASURE is a measure that reduces long-term system cost (LSC) and/or source energy consumption using communication and control technology to shift electricity use across hours of the day to decrease energy use on-peak or increase energy use off-peak, including but not limited to energy storage, or HVAC or water heating load shifting.

DEMAND RESPONSE is short-term changes in electricity usage by end-use customers from their normal consumption patterns. Demand response may be in response to:

a. changes in the price of electricity; or
b. participation in programs or services designed to modify electricity use:
    i. in response to wholesale market prices; or
    ii. when system reliability is jeopardized.

DEMAND RESPONSE PERIOD is a period of time during which electricity loads are modified in response to a demand response signal.

DEMAND RESPONSE SIGNAL is a signal that indicates a price or a request to modify electricity consumption, for a limited time period.

DEMAND RESPONSIVE CONTROL is an automatic control that is capable of receiving and automatically responding to a demand response signal.

DEMISING PARTITION is a wall, fenestration, floor or ceiling that separates conditioned space from enclosed unconditioned space or a controlled environment horticulture space.

DESICCANT DEHUMIDIFICATION SYSTEM is a mechanical dehumidification technology that uses a solid or liquid desiccant to remove moisture from the air.

DESIGN CONDITIONS are the parameters and conditions used to determine the performance requirements of space-conditioning systems. Design conditions for determining design heating and cooling loads are specified in Section 140.4(b) for nonresidential and hotel/motel buildings, in Section 150.0(h) for single-family residential buildings, and in Sections 160.3(b) and 170.2(c) for multifamily buildings.

DESIGN HEAT GAIN RATE is the total calculated heat gain through the building envelope under design conditions.

DESIGN HEAT LOSS RATE is the total calculated heat loss through the building envelope under design conditions.

DESIGN REVIEW is an additional review of the construction documents (drawings and specifications) that seeks to improve compliance with existing Title 24 regulations, to encourage adoption of best practices in design, and to encourage designs that are constructable and maintainable. It is an opportunity for an experienced design engineer or architect to look at a project with a fresh perspective in an effort to catch missing or unclear design information and to suggest design enhancements.

DEW POINT TEMPERATURE is the vapor saturation temperature at a specified pressure for a substance undergoing phase change from vapor to liquid.

DIRECT DIGITAL CONTROL (DDC) is a type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control mechanical devices.

DIRECT-VENT APPLIANCE or "sealed combustion" appliance is an appliance that is constructed and installed so that air from combustion is derived directly from the outdoors and flue gases are discharged to the outdoors.

DISPLAY PERIMETER is the length of an exterior wall in a Group B; Group F, Division 1; or Group M Occupancy that immediately abuts a public sidewalk, measured at the sidewalk level for each story that abuts a public sidewalk.

DOMESTIC HOT WATER SYSTEM APPURTENANCE are all elements that are in series in a domestic hot water distribution system, including fittings (elbows, tees, flanges, etc.), pumps, valves (isolation, mixing, balancing, check, etc.), strainers, hose bibs, coil u-bends, meters, sensors, heat exchangers and air separators.

DOMESTIC WATER HEATING SYSTEMS (see "service water heating").

DOOR is an operable opening in the building envelope including swinging and roll-up doors, fire doors, pet doors and access hatches with less than 25 percent glazed area. When that operable opening has 25 percent or more glazed area it is a glazed door. See Fenestration: Glazed Door.

DOOR AREA is the total rough opening area which includes the door, and when present, the fenestration, and the fenestration frame components in the door frame assembly.

DRAIN WATER HEAT RECOVERY (DWHR) is a system that recovers heat from effluent in waste piping and uses it to preheat water in a domestic or service water-heating system in order to reduce water-heating energy usage.

DRY COOLER is a fan-powered heat rejection device that includes a water or glycol circuit connected by a closed circulation loop refrigerant condenser and is air-cooled.

DUAL-FUEL HEAT PUMP is an electric heat pump with gas furnace supplemental heat that alternates between the two fuel sources.

DUCT SEALING is a procedure for installing a space-conditioning distribution system that minimizes leakage of air from or to the distribution system. Minimum specifications for installation procedures, materials, diagnostic testing and field verification are contained in the Reference Residential Appendix RA3 and Reference Nonresidential Appendix NA1.

DUCT SYSTEM is all the ducts, duct fittings, plenums and fans when assembled to form a continuous passageway for the distribution of air.

DUCT WALL PENETRATIONS are openings to the duct wall made by pipes, holes, conduit, tie rods or wires.

DUCTED SYSTEM is an air conditioner or heat pump, either a split system or single-packaged unit, that is designed to be permanently installed equipment and delivers conditioned air to an indoor space through a duct.

DWELLING is a building that contains one or two dwelling units used, intended or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

DWELLING UNIT is a single unit providing complete, independent living facilities for one or more persons including access, permanent provisions for living, sleeping, eating, cooking and sanitation.

DWELLING UNIT, ATTACHED is a dwelling unit that shares a common wall or common floor/ceiling with another dwelling unit.

DWELLING UNIT, JUNIOR ACCESSORY, or JADU is a dwelling unit that is no more than 500 square feet in size and contained entirely within a newly constructed or existing single-family building. A JADU includes a kitchen, a separate entrance from the main entrance to the building, and an interior entry to the main living area. A JADU may include separate sanitation facilities, or may share sanitation facilities within the newly constructed or existing single-family building.

DX-DEDICATED OUTDOOR AIR SYSTEM UNIT (DX-DOAS) is a type of air-cooled, water-cooled or water-source DOAS unit that dehumidifies 100-percent outdoor air and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designed supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the conditioned spaces. It may precondition outdoor air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

EAST-FACING (See "orientation.")

ECONOMIZER, AIR, is a ducting arrangement, including dampers, linkages and an automatic control system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical cooling.

ECONOMIZER, PUMPED REFRIGERANT, is a system by which the supply air of a cooling system is cooled directly by refrigerant pumped between indoor and outdoor units during cooler ambient temperatures in order to reduce or eliminate the need for mechanical cooling.

ECONOMIZER, WATER, is a system by which the supply air of a cooling system is cooled directly or indirectly by evaporation of water in order to reduce or eliminate the need for mechanical cooling.

ELECTRICAL POWER DISTRIBUTION SYSTEMS. The following definitions are intended to apply to Section 130.5 only:

ELECTRICAL METERING is a device or system for measuring the electrical power and energy supplied to a customer or premise(s).

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EQUIPMENT. A general term, including devices, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.

LOW VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER is a distribution transformer that has an input voltage of 600 volts or less, that is air-cooled, and that does not use oil as a coolant.

PLUG LOAD is the energy consumed by any appliances or electronic device that is plugged into a receptacle or receptacle outlet. Plug loads are not related to general lighting, heating, ventilation, cooling, and water heating, domestic and service water system, renewable power, information technology equipment, computer room electronic equipment, and electric vehicle charging.

SERVICE is the conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premise served.

SERVICE EQUIPMENT is the necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

ELECTRONICALLY-COMMUTATED MOTOR is a brushless DC motor with a permanent magnet rotor that is surrounded by stationary motor windings, and an electronic controller that varies rotor speed and direction by sequentially supplying DC current to the windings.

EMITTANCE, THERMAL is the ratio of the radiant heat flux emitted by a sample to that emitted by a blackbody radiator at the same temperature.

ENCLOSED SPACE is space that is substantially surrounded by solid surfaces, including walls, ceilings or roofs, doors, fenestration areas, and floors or ground.

> **ENERGY BUDGET** is the maximum energy consumption that a proposed building, or portion of a building, can be designed to consume, calculated using Commission-approved compliance software as specified by Section 10-109 of the Energy Code and the Alternative Calculation Method Reference Manual. The energy budget for newly constructed buildings are expressed in terms of the Long-Term System Cost (LSC) and Source Energy. The energy budget for additions and alterations is expressed in terms of LSC.

> **ENERGY COMMISSION (CEC)** is the California State Energy Resources Conservation and Development Commission.

ENERGY EFFICIENCY RATIO (EER) is the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy input (in watts), of a cooling system under designated operating conditions, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

ENERGY EFFICIENCY RATIO 2 (EER2) is the ratio of the average rate of space cooling capacity (Btu/h) delivered to the average rate of electrical energy consumed by the air conditioner or heat pump as determined in accordance to the test method in 10CFR430 Subpart B Appendix M1. EER is expressed in Btu/Wh.

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) is an automated control system that regulates the energy consumption of a building by controlling the operation of energy-consuming systems and is capable of monitoring loads and adjusting operations in order to optimize energy usage and respond to demand response signals.

ENERGY OBTAINED FROM DEPLETABLE SOURCES is electricity purchased from a public utility, or any energy obtained from coal, oil, natural gas or liquefied petroleum gases.

> **ENERGY OBTAINED FROM NONDEPLETABLE SOURCES** is energy that is not energy obtained from depletable sources.

ENFORCEMENT AGENCY is the city, county or state agency responsible for issuing a building permit.

ENTHALPY RECOVERY RATIO (ERR) is a ratio of the change in enthalpy of the outdoor air supply to the difference in enthalpy between the entering supply airflow and the entering exhaust airflow, with no adjustment to account for that portion of the psychometric change in the leaving supply airflow that is the result of leakage of entering exhaust airflow rather than exchange of heat or moisture between the airstreams.

ENTIRE BUILDING is the ensemble of all enclosed space in a building, including the space for which a permit is sought, plus all existing conditioned and unconditioned space within the structure.

> **ENVELOPE** (See "Building envelope.")

> **EXECUTIVE DIRECTOR** is the Executive Director of the Energy Commission.

EXFILTRATION is uncontrolled outward air leakage from inside a building, including leakage through cracks and interstices, around windows and doors, and through any other exterior partition or duct penetration.

EXTERIOR FLOOR/SOFFIT is a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include those on grade.

EXTERIOR PARTITION is an opaque, translucent or transparent solid barrier that separates conditioned space from ambient air or space. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground.

EXTERIOR ROOF/CEILING is an exterior partition, or a demising partition, that has a slope less than 60 degrees from horizontal, that has conditioned space below, and that is not an exterior door or skylight.

EXTERIOR ROOF/CEILING AREA is the area of the exterior surface of exterior roof/ceilings.

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EXTERIOR WALL is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building and which has a slope of 60 degrees or greater with the horizontal plane. An exterior wall or partition is not an exterior floor/soffit, exterior door, exterior roof/ceiling, window, skylight or demising wall.

EXTERIOR WALL AREA is the area of the opaque exterior surface of exterior walls.

FAÇADE is the contiguous exterior of a building surface, but not limited to fenestration products.

FACTORY is a build, structure or space designated as Factory Group F that is used for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair, or processing operations.

FACTORY-ASSEMBLED COOLING TOWERS are cooling towers constructed from factory-assembled modules either shipped to the site in one piece or put together in the field.

FAN, EMBEDDED is a fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

FAN ARRAYS are multiple fans in parallel and in a single enclosure between two plenum sections in an air distribution system, where plenum means a compartment or chamber that forms a part of the air distribution system, and that is not used for occupancy or storage.

FAN ELECTRICAL INPUT POWER (FAN kWdesign) is the electrical input power in kilowatts required to operate an individual fan or fan array at design conditions. It includes the power consumption of motor controllers, if present.

FAN ENERGY INDEX (FEI) is the ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per ANSI/AMCA 208-18 at fan system design conditions.

FAN NAMEPLATE ELECTRICAL INPUT POWER (kW) is the nominal electrical input power rating stamped on a fan assembly nameplate.

FAN SYSTEM includes all the fans that contribute to the movement of air through a point of a common duct, plenum or cabinet.

FAN SYSTEM, COMPLEX means a fan system that combines a single-cabinet fan system with other supply fans, exhaust fans or both.

FAN SYSTEM, EXHAUST/RELIEF is a fan system dedicated to the removal of air from interior spaces to the outdoors.

FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) is a fan system that serves three or more space-conditioning zones where airflow to each zone is individually controlled based on heating, cooling and/or ventilation requirements, indoor fan airflow varies as a function of load, and the sum of the minimum zone airflows for each zone is 40 percent or less of the fan system design conditions.

FAN SYSTEM, RETURN is a fan system dedicated to removing air from interior spaces where some or all of the air is to be recirculated except during economizer operation.

FAN SYSTEM, SINGLE-CABINET is a fan system where a single fan, a single-fan array, a single set of fans operating in parallel, or fans or fan arrays in series and embedded in the same cabinet both supply air to a space and recirculate the air.

FAN SYSTEM, SUPPLY-ONLY is a fan system that provides supply air to interior spaces and does not recirculate the air.

FAN SYSTEM, TRANSFER is a fan system that exclusively moves air from one occupied space to another.

FAN SYSTEM AIRFLOW (cfm) is the sum of the airflow of all fans with fan electrical input power greater than 1 kW at fan system design conditions, excluding the airflow that passes through downstream fans with fan input power less than 1 kW.

FAN SYSTEM DESIGN CONDITIONS are operating conditions that can be expected to occur during normal system operation that result in the highest supply airflow rate to or from the conditioned spaces served by the fan system.

FAN SYSTEM ELECTRICAL INPUT POWER (Fan $kW_{design,system}$) is the sum of the fan electrical input power (Fan kW_{design}) in kilowatts of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces, return it to the source, exhaust it to the outdoors or transfer it to another space.

FENESTRATION: Includes the following:

ACE is an NFRC-Approved Calculation Entity that conducts calculations of fenestration product ratings for certification authorization using the NFRC component modeling approach and issues label certificates to Specifying Authorities for product certification authorization in accordance with NFRC requirements.

ALTERED COMPONENT is a new fenestration component that has undergone an alteration other than a repair and is subject to all applicable standards requirements.

BAY WINDOW is a combination assembly which is composed of three or more individual windows either joined side by side or installed within opaque assemblies and which projects away from the wall on which it is installed. Center windows, if used, are parallel to the wall on which the bay is installed, the end panels or two side windows, are angled with respect to the center window. Common angles are 30° and 45°, although other angles may be employed.

CHROMOGENIC GLAZING is a class of switchable glazing that includes active materials (e.g., electrochromic) and passive materials (e.g., photochromic and thermochromic) permanently integrated into the glazing assembly. Their primary function is to switch reversibly from a high transmission state to a low transmission state with associated changes in VT and SHGC.

CLERESTORY FENESTRATION is fenestration installed above a roofline greater than or equal to 60 degrees from the horizontal, or any portion of exterior vertical glazing greater than 8 feet per floor above the finished floor of a space.

CMA (component modeling approach) is a fenestration product certification program from the National Fenestration Rating Council (NFRC) that enables energy-related performance ratings for nonresidential fenestration products, including the thermal performance *U*-factor, solar heat gain coefficient, and visible transmittance.

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CMAST (component modeling approach software tool) is an NFRC approved software that allows a user to create a fenestration product "virtually" and generate its energy-related performance ratings, including the thermal performance *U*-factor, solar heat gain coefficient, and visible transmittance.

CURTAIN WALL/STOREFRONT is an external non-bearing wall intended to separate the exterior nonconditioned and interior conditioned spaces. It also consists of any combination of framing materials, fixed glazing, opaque glazing, operable windows or other in-fill materials.

Note: Window wall is also included as part of the curtain wall/storefront fenestration category.

DUAL-GLAZED GREENHOUSE WINDOWS is a double glass pane separated by an air or other gas space that adds conditioned volume but not conditioned floor area to a building.

DYNAMIC GLAZING SYSTEMS are glazing systems that have the ability to reversibly change their performance properties, including *U*-factor, Solar Heat Gain Coefficient (SHGC) and/or Visible Transmittance (VT) between well-defined end points. These may include, but are not limited to, chromogenic glazing systems and integrated shading systems (defined below). Dynamic Glazing systems do not include internally mounted or externally mounted shading devices that attach to the window framing/glazing that may or may not be removable.

FENESTRATION ALTERATION is any change to an existing building's exterior fenestration product that is not a repair (see "fenestration repair") that:

i. Replaces existing fenestration in an existing wall or roof with no net area added; or
ii. Replaces existing fenestration and adds new net area in the existing wall or roof; or
iii. Adds a new window that increases the net fenestration area to an existing wall or roof.

FENESTRATION AREA is the rough opening area of any fenestration product.

FENESTRATION PRODUCT is any transparent or translucent material plus any sash, frame, mullions and dividers, in the facade of a building, including, but not limited to, windows, glazed doors, skylights, curtain walls, dynamic glazing, garden windows, glass block and glazing used in greenhouses.

FENESTRATION REPAIR is the reconstruction or renewal for the purpose of maintenance of any fenestration product, component or system and shall not increase the preexisting energy consumption of the repaired fenestration product, component, system or equipment. Replacement of any component, system or equipment for which there are requirements in the Standards are considered an alteration (see Fenestration, alteration) and not a repair and is subject to the requirements of Part 6 of the Standards.

FIELD-FABRICATED is a fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product. Field fabricated does not include site-built fenestration.

FIN is an opaque surface, oriented vertically and projecting outward horizontally from an exterior vertical surface.

FIN OFFSET is the horizontal distance from the edge of exposed exterior glazing at the jamb of a window to the fin.

FIN PROJECTION is the horizontal distance, measured outward horizontally, from the surface of exposed exterior glazing at the jamb of a window to the outward edge of a fin.

FIXED is fenestration that is not designed to be opened or closed.

GLAZED DOOR is an exterior door having a glazed area of 25 percent or greater of the area of the door. Glazed doors shall meet fenestration product requirements. See "door."

GREENHOUSE or **GARDEN WINDOW** is a window unit that consists of a three-dimensional, five-sided structure generally protruding from the wall in which it is installed. Operating sash may or may not be included.

HORIZONTAL SLATS, when referring to a daylighting device, is a set of adjacent surfaces located directly adjacent to vertical fenestration, oriented horizontally and projecting horizontally from its interior or exterior vertical surface.

INTEGRATED SHADING SYSTEM is a class of fenestration products including an active layer: e.g., shades, louvers, blinds or other materials permanently integrated between two or more glazing layers. The *U*-factor and/or SHGC and VT of the insulating glass assembly can be altered by reversibly changing the enclosed active layer.

LIGHT SHELF is an adjacent, opaque surfaced daylighting device located at the sill of clerestory glazing, oriented horizontally and projecting horizontally from an interior or exterior vertical surface.

MANUFACTURED or KNOCKED DOWN PRODUCT is a fenestration product constructed of materials that are factory cut or otherwise factory formed with the specific intention of being used to fabricate a fenestration product. Knocked down or partially assembled products may be sold as a fenestration product when provided with temporary and permanent labels as described in Section 10-111, or as a site-built fenestration product when not provided with temporary and permanent labels as described in Section 10-111.

NFRC 100 is the National Fenestration Rating Council document titled "Procedure for Determining Fenestration Product *U*-factors," (2020) (ANSI/NFRC 100-2020).

NFRC 200 is the National Fenestration Rating Council document titled "Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence," (2020) (ANSI/NFRC 200-2020).

NFRC 202 is the National Fenestration Rating Council document titled "Procedures for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence," (2020) (ANSI/NFRC 202-2020).

NFRC 203 is the National Fenestration Rating Council document titled "Procedure for Determining Visible Transmittance of Tubular Daylighting Devices," (2020) (ANSI/NFRC 203-2020).

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NFRC 400 is the National Fenestration Rating Council document titled "Procedure for Determining Fenestration Product Air Leakage," (2020) (ANSI/NFRC 400-2020).

OPERABLE SHADING DEVICE is a device at the interior or exterior of a building or integral with a fenestration product, which is capable of being operated, either manually or automatically, to adjust the amount of solar radiation admitted to the interior of the building.

RELATIVE SOLAR HEAT GAIN COEFFICIENT (RSHGC) is the ratio of solar heat gain through a fenestration product (corrected for external shading) to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

SITE-BUILT is fenestration designed to be field-glazed or field assembled units using specific factory cut or otherwise factory formed framing and glazing units that are manufactured with the intention of being assembled at the construction site. These include storefront systems, curtain walls and atrium roof systems.

SKYLIGHT ROOF RATIO (SRR) is the ratio of the skylight area to the gross exterior roof area.

SOLAR HEAT GAIN COEFFICIENT (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

SPANDRAL is opaque glazing material most often used to conceal building elements between floors of a building so they cannot be seen from the exterior, also known as "opaque in-fill systems."

TINTED GLASS is colored glass by incorporation of a mineral admixture resulting in a degree of tinting. Any tinting reduces both visible and radiant transmittance.

VERTICAL FENESTRATION is all fenestration other than skylights and doors.

VISIBLE REFLECTANCE is the reflectance of light at wavelengths from 410 to 722 nanometers.

VISIBLE TRANSMITTANCE (VT) is the ratio (expressed as a decimal) of visible light that is transmitted through a glazing fenestration. The higher the VT rating, the more light is allowed through a window.

WINDOW is fenestration that is not a skylight and that is an assembled unit consisting of a frame and sash component holding one or more pieces of glazing.

WINDOW AREA is the area of the surface of a window, plus the area of the frame, sash and mullions.

WINDOW HEAD HEIGHT is the height from the floor to the top of the vertical fenestration.

WINDOW WALL RATIO (WWR) is the ratio of the window area to the gross exterior wall area.

FIELD ERECTED COOLING TOWERS are cooling towers which are custom designed for a specific application and which cannot be delivered to a project site in the form of factory assembled modules due to their size, configuration, or materials of construction.

FIREPLACE is a hearth and fire chamber, or similar prepared place, in which a fire may be made, and which is built in conjunction with a flue or chimney, including but not limited to factory-built fireplaces, masonry fireplaces, and masonry heaters as further clarified in the CBC.

FLOOR/SOFFIT TYPE is a type of floor/soffit assembly having a specific heat capacity, framing type and *U*-factor.

FLUID COOLER is a fan-powered heat rejection device that includes a water or glycol circuit connected by a closed circulation loop to a liquid-cooled refrigerant condenser, and may be either evaporative-cooled, or air-cooled, or a combination of the two.

FLUX is the rate of energy flow per unit area.

FOOD PREPARATION EQUIPMENT is cooking equipment intended for commercial use, including coffee machines, espresso coffee makers, conductive cookers, food warmers including heated food servers, fryers, griddles, nut warmers, ovens, popcorn makers, steam kettles, ranges and cooking appliances for use in commercial kitchens, restaurants or other business establishments where food is dispensed.

FREEZER is a space designed to be capable of operation at less than 28°F.

GAS COOLER is a refrigeration component that reduces the temperature of a refrigerant vapor by rejecting heat to air mechanically circulated over its heat transfer surface. Used by a CO_2 refrigeration system in transcritical mode, and normally also capable of operating in subcritical mode.

GAS COOLING EQUIPMENT is cooling equipment that produces chilled water or cold air using natural gas or liquefied petroleum gas as the primary energy source.

GAS HEATING SYSTEM is a system that uses natural gas or liquefied petroleum gas as a fuel to heat a conditioned space.

GAS LOG is a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs, and designed for installation only in a vented fireplace.

GLAZING (See "fenestration product.")

GLOBAL WARMING POTENTIAL (GWP) is the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time.

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GLOBAL WARMING POTENTIAL VALUE (GWP Value) is the 100-year GWP value published by the Intergovernmental Panel on Climate Change (IPCC) in either its Second Assessment Report (SAR) (IPCC, 1995), or its Fourth Assessment A-3 Report (AR4) (IPCC, 2007). Both the 1995 IPCC SAR values and the 2007 IPCC AR4 values are published in Table 2.14 of the 2007 IPCC AR4. The SAR GWP values are found in column "SAR (100-yr)" of Table 2.14.; the AR4 GWP values are found in column "100 yr" of Table 2.14.

GOVERNMENTAL AGENCY is any public agency or subdivision thereof, including, but not limited to, any agency of the state, a county, a city, a district, an association of governments or a joint power agency.

GROSS EXTERIOR ROOF AREA is the sum of the skylight area and the exterior roof/ceiling area.

GROSS EXTERIOR WALL AREA is the sum of the window area, door area and exterior wall area.

HABITABLE SPACE is space in a building for living, sleeping, eating or cooking, excluding bathrooms, toilets, hallways, storage areas, closets, utility rooms and similar areas are not considered habitable spaces. (See also "occupiable space".)

HABITABLE STORY is a story that contains habitable space and that has at least 50 percent of its volume above grade.

HEALTHCARE FACILITY is a health facility as defined in the California Health and Safety Code Division 2, Chapter 2, §1250 or clinic as defined in the California Health and Safety Code Division 2, Chapter 1, Section 1204 that is located within a health facility.

HEAT CAPACITY (HC) is the measurable physical quantity that characterizes the amount of heat required to change a substance's temperature by a given amount.

HEAT PUMP is an appliance that consists of one or more assemblies; that uses an indoor conditioning coil, a compressor, and a refrigerant-to-outdoor air heat exchanger to provide air heating; and that may also provide air cooling, dehumidifying, humidifying, circulating, or air cleaning.

HEAT PUMP WATER HEATER (HPWH) (See "Water heater.")

HEATED SLAB FLOOR is a concrete floor either on-grade, raised, or a lightweight concrete slab topping. Heating is provided by a system placed within or under the slab and is sometimes referred to as a radiant slab floor.

HEATING EQUIPMENT is equipment used to provide mechanical heating for a room or rooms in a building.

HEATING SEASONAL PERFORMANCE FACTOR (HSPF) is the total heating output of a central air-conditioning heat pump (in Btu) during its normal use period for heating divided by the total electrical energy input (in watt-hours) during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

HEATING SEASONAL PERFORMANCE FACTOR 2 (HSPF2) is the HSPF metric for residential central heat pumps effective January 1, 2023, as created by the U.S. Department of Energy "ISSUANCE 2016-11-30 Energy Conservation Program: Test Procedures for Central Air Conditioners and Heat Pumps, Final Rule."

HIGH-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel, of occupancy Group R-2 or R-4 with four or more habitable stories.

HORTICULTURAL LIGHTING consists of luminaires used for plant growth and maintenance. Horticultural luminaires may have either plug-in or hard-wired connections for electric power.

HOTEL/MOTEL is a building or buildings that has six or more guest rooms or a lobby serving six or more guest rooms, where the guest rooms are intended or designed to be used, or which are used, rented or hired out to be occupied, or which are occupied for sleeping purposes by guests, and all conditioned spaces within the same building envelope. Hotel/motel includes all conditioned spaces which are (1) on the same property as the hotel/motel, (2) served by the same central heating, ventilation and air-conditioning system as the hotel/motel, and (3) integrally related to the functioning of the hotel/motel as such, including, but not limited to, exhibition facilities, meeting and conference facilities, food service facilities, lobbies and laundries. Hotel/motel also includes the following:

A building of Occupancy Group R-1,

Vacation timeshare properties and hotel or motel buildings of Occupancy Group R-2, and

The following types of Occupancy Group R-3:

Congregate residences for transient use,

Boarding houses of more than 6 guests, and

Alcohol or drug abuse recovery homes of more than 6 guests.

HVAC SYSTEM is a space-conditioning system or a ventilation system.

HVI 915 is the Home Ventilating Institute document titled "HVI Loudness Testing and Rating Procedure," 2020 (HVI Publication 915-2020).

HVI 916 is the Home Ventilating Institute document titled "HVI Airflow Test Procedure," 2020 (HVI Publication 916-2020).

HVI 920 is the Home Ventilating Institute document titled "HVI Product Performance Certification Procedure Including Verification and Challenge," 2020 (HVI Publication 920-2020).

IES HB (See "IES Lighting Library.")

IES LIGHTING LIBRARY, formerly called the **"**IES Lighting Handbook (IES HB)," is the Illuminating Engineering Society document titled "The IES Lighting Library™."

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INTEGRATED SEASONAL COEFFICIENT OF PERFORMANCE (ISCOP) is a seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the two COP values for the heating season of a DX-DOAS unit water or air source heat pump, expressed in W/W.

INTEGRATED SEASONAL MOISTURE REMOVAL EFFICIENCY (ISMRE) is a seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the four dehumidification moisture removal efficiency (MRE) ratings required for DX-DOAS units, expressed in lb of moisture/kWh.

IES LM-79 is an American National Standard authored by the Illuminating Engineering Society and titled "Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products," (2019) (ANSI/IES LM-79-19). <

IES LS-1-20 is an American National Standard authored by the Illuminating Engineering Society and titled "Lighting Science: Nomenclature and Definitions for Illuminating Engineering," 2020 (ANSI/IES LS-1-20).

IES TM-15-20 is an American National Standard authored by the Illuminating Engineering Society and titled "Technical Memorandum: Luminaire Classification System for Outdoor Luminaires," (2020) (ANSI/IES TM-15-20).

INDOOR GROWING is a type of CEH space in a building with a Skylight Roof Ratio less than 50 percent. Growing plants in a warehouse with or without skylights is an example of indoor growing.

INFILTRATION is uncontrolled inward air leakage from outside a building or unconditioned space, including leakage through cracks and interstices, around windows and doors, and through any other exterior or demising partition or pipe or duct penetration. See AIR BARRIER.

INFORMATION TECHNOLOGY EQUIPMENT (ITE) includes computers, data storage, servers and network/communication equipment located in a computer room.

INTEGRATED ENERGY EFFICIENCY RATIO (IEER) is a single-number cooling part-load efficiency figure of merit calculated as specified by the method described in ANSI/AHRI Standard 340/360/1230. This metric replaces the IPLV for ducted and non-ducted units.

INTEGRATED HVAC SYSTEM is an HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems may include, but are not limited to: HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and dehumidifiers modified to allow external heat rejection.

INTEGRATED PART-LOAD VALUE (IPLV) is a single-number cooling part-load efficiency figure of merit calculated as specified by the method described in ANSI/AHRI Standard 550/590 for use with chillers.

ISO 5801 is the International Organization for Standardization document titled "Fans—Performance testing using standardized airways," 2017 (ISO 5801:2017).

ISO 13256-1 is the International Organization for Standardization document titled "Water-source heat pumps—Testing and rating for performance—Part 1: Water-to-air and brine-to-air heat pumps," 2012 [ANSI/AHRI/ASHRAE ISO 13256-1:1998 (RA 2012)].

ISO 13256-2 is the International Organization for Standardization document titled "Water-source heat pumps—Testing and rating for performance—Part 1: Water-to-water and brine-to-water heat pumps," 2012 [ANSI/AHRI/ASHRAE ISO 13256-2-01 (R2012)].

ISO 17025 is the International Organization for Standardization document titled "General Criteria for the Competence of Testing and Calibration Laboratories," 2017 (ISO/IEC 17025:2017).

ITE DESIGN LOAD is the combined power of all the ITE loads for which the ITE cooling system is designed.

KITCHEN, FULL-SERVICE COMMERCIAL is a kitchen dedicated to an establishment that offers table service by waitstaff.

KITCHEN, INSTITUTIONAL COMMERCIAL is a kitchen dedicated to a foodservice establishment that provides meals at institutions including schools, colleges and universities, hospitals, correctional facilities, private cafeterias, nursing homes, and other buildings or structures in which care or supervision is provided to occupants.

KITCHEN, QUICK-SERVICE COMMERCIAL is a kitchen dedicated to an establishment primarily engaged in providing fast food, fast casual, or limited services. Food and drink may be consumed on the premises, taken out, or delivered to the customer's location.

LANGELIER SATURATION INDEX (LSI) is expressed as the difference between the actual system pH and the saturation pH. LSI indicates whether water will precipitate, dissolve or be in equilibrium with calcium carbonate, and is a function of hardness, alkalinity, conductivity, pH and temperature.

LARGEST NET CAPACITY INCREMENT is the largest increase in capacity when switching between combinations of base compressors that is expected to occur under the compressed air system control scheme.

LIGHTING definitions:

Accent lighting is directional lighting to emphasize a particular object or surface feature, or to draw attention to a part of the field of view. It can be recessed, surface mounted or mounted to a pendant, stem or track, and can be display lighting. It shall not provide general lighting.

Astronomical time-switch control is a lighting control that controls lighting based on the time of day and astronomical events such as sunset and sunrise, accounting for geographic location and calendar date.

Automatic scheduling control is a time-based lighting control that is capable of being programmed to reduce or turn off lighting power for a portion of the night and to turn off lighting power for the day. <

Automatic time switch control controls lighting based on the time of day.

Captive-key override is a type of lighting control in which the key that activates the override cannot be released when the lights are in the on position.

Chandelier is a ceiling-mounted, close-to-ceiling or suspended decorative luminaire that uses glass, crystal, ornamental metals or other decorative material.

Color Rendering Index (CRI) is a measure of the degree of color shift that objects undergo when illuminated by the lighting source as compared with the color of the same objects when illuminated by a reference source of comparable color temperature. CRI is calculated according to CIE 13.3.

Colored light source is a light source designed and marketed as a colored light source and not designed or marketed for general lighting applications with either of the following characteristics maintained throughout all modes of operation including color changing operation:

(1) A Color Rendering Index (CRI) less than 40, as determined according to the method set forth in CIE Publication 13.3; or

(2) A Correlated Color Temperature as measured with ANSI/IES LM-66-20 or ANSI/IES LM-79-19 (as appropriate) and calculated with CIE 15, which does not have a corresponding nominal CCT designation in ANSI C78.377-2017.

Compact fluorescent lamp is a fluorescent lamp with a small-diameter glass tube (T5 or smaller) that is folded, bent or bridged to create a long discharge path in a small volume. The lamp designs generally include an amalgam and a cold chamber, or a cold spot, to control the mercury vapor pressure and light output. The lamp designs generally include an amalgam and a cold chamber, or a cold spot, to control the mercury vapor pressure and light output.

Correlated Color Temperature (CCT) is the absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source.

Countdown timer switch turns lighting or other loads ON when activated using one or more selectable countdown time periods and then automatically turns lighting or other loads OFF when the selected time period has elapsed.

Daylight continuous dimming controls are continuous dimming controls that vary the luminous flux in response to available daylight.

Daylight Responsive Control adjusts the luminous flux of the electric lighting system in either a series of steps or by continuous dimming in response to available daylight. This kind of control uses one or more photosensors to detect changes in daylight illumination and then automatically adjusts the electric lighting levels in response.

Decorative (lighting/luminaires) is lighting or luminaires installed only for aesthetic purposes and that does not serve as display lighting or general lighting. Decorative luminaires are chandeliers, sconces, lanterns, neon or cold cathode, light emitting diodes, theatrical projectors, moving lights and light color panels not providing general lighting or task lighting.

Dimmer is a device used to control the intensity of light emitted by a luminaire by controlling the voltage or current available to it.

Dimmer, continuous means a dimmer that varies the luminous flux of the electric lighting system over a continuous range from the device's maximum light output to the device's minimum light output without visually apparent abrupt changes in light level between the various steps.

Dimmer, forward phase cut varies the luminous flux of the electric lighting system in which a portion of the alternating current voltage waveform supplying to the light source is removed.

Dimmer, stepped varies the luminous flux of the electric lighting system in one or more predetermined discrete steps between maximum light output and OFF with changes in light level between adjacent steps being visually apparent.

Display lighting, case is lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance of small art objects, artifacts or valuable collections that involve customer inspection of very fine detail from outside of a glass enclosed display case.

Display lighting, floor is supplementary lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance required to highlight features, such as merchandise on a clothing rack or sculpture or free standing of artwork, not displayed against a wall.

Display lighting, wall is supplementary lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance required to highlight features, such as merchandise on a shelf or wall-mounted artwork, displayed on perimeter walls.

Display lighting, window is lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance of objects such as merchandise, goods and artifacts, in a show window, to be viewed from the outside of a space through a window.

Driver, when used in relation to solid state lighting, is a device that uses semiconductors to control and supply dc power for LED starting and operation.

Enclosed luminaires are luminaires which contain enclosed lamp compartments where ventilation openings are less than 3 square inches per lamp in the lamp compartment as defined by UL 1598.

General lighting is installed electric lighting that provides a uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect, exclusive of daylighting, and also known as ambient lighting.

GU-24 is the designation of a lamp holder and socket configuration, based on a coding system by the International Energy Consortium, where “G” indicates the broad type of two or more projecting contacts, such as pins or posts, “U” distinguishes between

lamp and holder designs of similar type but that are not interchangeable due to electrical or mechanical requirements, and "24" indicates 24 millimeters center to center spacing of the electrical contact posts.

Illuminance is the area density of the luminous flux incident at a point on a surface.

Illumination is commonly used in a qualitative sense to designate the act of illuminating or the state of being illuminated.

Inseparable Solid State Lighting (SSL) Luminaire is a luminaire featuring solid state lighting components such as LEDs, light engines and/or driver components which cannot be easily removed or replaced by the end user, thus requiring replacement of the entire luminaire. Removal of solid state lighting components may require the cutting of wires, use of a soldering iron, or damage to or destruction of the luminaire. If solid state lighting components are not removable without destruction to the luminaire, the luminaire is deemed inseparable.

Institutional tuning is the process of adjusting the maximum light output of lighting systems to support visual needs or save energy. Institutional tuning differs from personal tuning in that the control strategy is implemented at the institutional rather than the individual user level, and maximum light level adjustments are available only to authorized personnel.

Integrated LED lamp is an integrated assembly composed of light emitting diode (LED) packages (components) or LED arrays (modules), as well as an LED driver, an ANSI standard base, and other optical, thermal, mechanical, and electrical components. The device is intended to connect directly to the branch circuit through a corresponding ANSI standard lamp-holder (socket). (ANSI/IES LS-1-20)

Lamp is an electrical appliance that produces optical radiation for the purpose of visual illumination, designed with a base to provide an electrical connection between the lamp and a luminaire, and designed to be installed into a luminaire. A lamp is not a luminaire and is not an LED retrofit kit.

Landscape lighting is a type of outdoor lighting that is recessed into or mounted on the ground, paving or raised deck, which is mounted less than 42 inches above grade or mounted onto trees or trellises, and that is intended to be aimed only at landscape features.

Lantern is an outdoor luminaire that uses an electric lamp to replicate the appearance of a pre-electric lantern, which used a flame to generate light.

LED driver is a device composed of a power source and light emitting diode (LED) control circuitry designed to operate an LED package (component), an LED array (module) or an LED lamp. An LED driver is a power source that adjusts the voltage or current to LEDs, ranging in complexity from a resistor to a constant voltage or constant current power supply. An LED driver is also known and referred to as lamp control gear.

LED light engine is an integrated assembly composed of light emitting diode (LED) packages (components) or LED arrays (modules), as well as an LED driver and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed. It does not use an ANSI standard base.

LED retrofit kit is a solid state lighting product intended to replace existing light sources and systems, including incandescent and fluorescent light sources, in previously installed luminaires that already comply with safety standards. These kits replace the existing light source and related electrical components, and are classified or certified to UL 1598C. They may employ an ANSI standard lamp base, either integral or connected to the retrofit by wire leads. LED retrofit kit does not include self-ballasted lamps.

Light is a form of radiant energy that is capable of exciting the retina and producing a visual sensation. The visible portion of the electromagnetic spectrum extends from about 380 to about 770 nanometers.

Lighting, or illumination, is commonly used in a qualitative or general sense to designate the act of illuminating or the state of being illuminated.

Lighting control, self-contained is a unitary lighting control module that requires no additional components to be a fully functional lighting control.

Lighting control system requires two or more components to be installed in the building to provide all the functionality required to make up a fully functional and compliant lighting control.

Light emitting diode (LED) is a p-n junction semiconductor device that emits incoherent optical radiation when forward-biased. The optical emission may be in the ultraviolet, visible or infrared wavelength regions.

Line-voltage track lighting is equipped with luminaires that use line-voltage lamps or that are equipped with integral transformers at each luminaire.

Low voltage is less than 90 volts.

Low-voltage track lighting is equipped with remote transformers for use with low-voltage equipment along the entire length of track.

Luminaire is a complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts that distribute the light, to position and protect the light source, and to connect the light source to the power supply.

Luminaire alteration is adding luminaires, removing and reinstalling luminaires, or combined replacement of lamps and ballasts or drivers. Luminaire alterations do not include repairs, such as replacing lamps only, ballasts or drivers only, diffusers, shades or luminaire covers.

Luminance is the luminous intensity of the source or surface divided by the area of the source or surface seen by the observer.

Luminous efficacy is a measure of the luminous efficiency of a light source. It is the quotient of the total luminous flux emitted by the total light source power input, expressed in lm/W.

Luminous flux is the time rate of flow of radiant energy, evaluated in terms of a standardized visual response.

Luminous maintenance (often referred to as "lumen flux maintenance" or "lumen maintenance") is the remaining luminous flux output, typically expressed as a percentage of initial luminous flux output, at any selected elapsed operating time. Luminous maintenance is the converse of luminous flux depreciation (or "lumen depreciation").

Marquee lighting is a permanent lighting system consisting of one or more rows of many small lamps, including light emitting diodes (LEDs) lamps, tungsten lamps, low pressure discharge lamps or fiber optic lighting, attached to a canopy.

Multilevel Astronomical Time Switch is an astronomical time-switch control that reduces lighting power in multiple steps.

Multilevel lighting control enables the intensity of lighting to be adjusted upward and downward.

Multiscene programmable control allows for two or more predefined lighting settings, in addition to all-OFF, for two or more groups of luminaires to suit multiple activities in the space.

Narrow band spectrum is a limited range of wavelengths (nm) concentric to a dominant peak wavelength in the visible spectrum. The limited range of wavelength shall be within 20 nm on either side of the peak wavelength at 50 percent of the peak wavelength's relative spectral power, and within 75 nm on either side of the peak wavelength at 10 percent of the peak wavelength's relative spectral power.

NEMA LSD 57 is the National Electrical Manufacturers Association document titled "Polyurethane Foam Application: Lighting Equipment," 2018 (NEMA LSD 57-2018).

NEMA SSL 7A is the National Electrical Manufacturers Association document titled "Phase Cut Dimming for Solid State Lighting: Basic Compatibility," 2015 (NEMA SSL 7A-2015).

Non-integrated LED lamp is an assembly composed of a light emitting diode (LED) array (module) or LED packages (components), and an ANSI standard base. The device is intended to connect to the LED driver of an LED luminaire through an ANSI standard lamp-holder (socket). The device cannot be connected directly to the branch circuit. (ANSI/IES LS-1-20)

Occupant sensing controls automatically control levels of illumination, allow for manual operation and consist of the following types:

Motion sensing control is used outdoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants, and automatically turns the lights ON when the area is occupied.

Occupant sensing control is used indoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants, and is capable of automatically turning the lighting load ON when an area is occupied.

Partial-ON occupant or motion sensing control automatically turns lights OFF after an area is vacated of occupants and is capable of automatically or manually turning ON part of the lighting load when an area is occupied.

Partial-OFF occupant or motion sensing control automatically dims the lighting or turns OFF part of the lighting load after an area is vacated of occupants, and is capable of automatically turning ON the lighting load or restoring it to full when an area is occupied.

Vacancy sensing control automatically turns lights OFF after an area is vacated of occupants but requires lights to be turned ON manually.

One-to-one alteration is either replacement of whole luminaires one for one, in which the only electrical modification involves disconnecting the existing luminaire and reconnecting the replacement luminaire, or when components of a luminaire are modified without replacing the entire luminaire.

Ornamental lighting/Luminaires are lighting or luminaires installed outdoors that are rated for 50 watts or less that are post-top luminaires, lanterns, pendant luminaires, chandeliers and marquee lighting, not providing general lighting or task lighting.

Pendant luminaire (Suspended luminaire) is a luminaire that is hung from a ceiling by supports.

Permanently installed lighting consists of luminaires that are affixed to land, within the meaning of Civil Code Sections 658 and 660, except as provided below. Permanently installed luminaires may be mounted inside or outside of a building or site. Permanently installed luminaires may have either plug-in or hardwired connections for electric power. Examples include track and flexible lighting systems; lighting attached to walls, ceilings, columns, inside or outside of permanently installed cabinets, internally illuminated cabinets, mounted on poles, in trees, or in the ground; attached to ceiling fans and integral to exhaust fans. Permanently installed lighting does not include portable lighting or lighting that is installed by the manufacturer in exhaust hoods for cooking equipment, refrigerated cases, food preparation equipment, and scientific and industrial equipment.

Photo control automatically turns lights ON and OFF, or automatically adjusts lighting levels, in response to the amount of daylight that is available. A photo control may also be one component of a field-assembled lighting system, the component having the capability to provide a signal proportional to the amount of daylight to a lighting control system to dim or brighten the electric lights in response.

Portable lighting is lighting equipment designed for manual portability, with plug-in connections for electric power, that is: table and freestanding floor lamps; attached to modular furniture; workstation task luminaires; luminaires attached to workstation panels; attached to movable displays; or attached to other personal property.

Post top luminaire is an outdoor luminaire that is mounted directly on top of a lamp-post.

Precision lighting is task lighting for commercial or industrial work that illuminates low contrast, finely detailed, or fast moving objects.

Radiant energy is energy travelling in the form of electromagnetic waves. It is measured in units of energy such as joules or kilowatt hours.

Radiant power is the time rate of flow of radiant energy. It is expressed preferably in watts.

Recessed luminaire is a luminaire that is mounted in the ceiling or behind a wall or other surface with the opening of the luminaire flush with the surface.

Sconce is a wall mounted decorative accent luminaire.

Security cameras are any operational camera used to enhance the safety and security within a general hardscape area.

Shut-off controls are any lighting control capable of automatically shutting OFF the lighting in a space when the space is typically unoccupied.

Solid State Lighting (SSL) is a family of light sources that includes: semiconductor light emitting diodes (LEDs); and organic light emitting diodes (OLEDs).

Source (light) is the general term used to reference a source of light. It can refer variously to an electric lamp, a light emitting diode (LED), an entire luminaire with lamp and optical control, or fenestration for daylighting.

Special effects lighting is lighting installed to give off luminance instead of providing illuminance, which does not serve as general, task or display lighting.

Task lighting is lighting directed to a specific surface or area, providing illumination for visual tasks. Task lighting is not general lighting.

Temporary lighting is a lighting installation, with plug-in connections, that does not persist beyond the time constraints specified in California Electrical Code Article 590.

Track lighting is a lighting equipment system consisting of an electrified power channel (track) and removable luminaires (lamp holders; track heads) that can be mechanically attached anywhere along the power channel. The luminaires can be repositioned and re-aimed as desired. Track lighting includes the following types:

Track lighting integral current limiter consists of a current limiter integral to the end-feed housing of a manufactured line-voltage track lighting system.

Track lighting supplementary overcurrent protection panel is a panelboard containing Supplementary Overcurrent Protection Devices as defined in Article 100 of the *California Electrical Code,* and used only with line voltage track lighting.

Track-mounted luminaires are luminaires designed to be attached at any point along a track lighting system. Track-mounted luminaires may be line-voltage or low-voltage.

Tunable lighting are light sources with the ability to alter their luminous flux and/or spectral power distribution. Tunable lighting includes the following types:

Color tunable light source is capable of emitting highly saturated light of varying hues, as well as white light, for example by varying the relative intensity of individual emitters within the light source.

Dim-to-warm (also known as warm dim) light source is capable of simultaneously decreasing its correlated color temperature as its light output decreases, typically resembling the change in color temperature of an incandescent lamp as it dims.

Tunable white light source is capable of adjusting its correlated color temperature while maintaining its relative light output and capable of adjusting its light output while maintaining its correlated color temperature.

LISTED is in accordance with Article 100 of the *California Electrical Code.*

LONG-TERM SYSTEM COST (LSC) is the CEC-projected present value of costs to California's energy system over a period of 30 years. LSC does not represent a prediction of individual utility bills.

LOW-GWP REFRIGERANT is a compound used as a heat transfer fluid or gas that is: (A) any compound or blend of compounds, with a GWP Value less than 150; and (B) U.S. EPA Significant New Alternatives Policy (SNAP)-approved; and (C) not an ozone depleting substance as defined in Title 40 of the Code of Federal Regulations, Part 82, §82.3 (as amended March 10, 2017).

LOW-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel, that is Occupancy Group:

R-2, multifamily, with three habitable stories or less; or

R-3, single family; or

U-building, located on a residential site.

LPG is liquefied petroleum gas.

MANUAL is capable of being operated by personal intervention.

MANUFACTURED DEVICE is any heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, plumbing fitting, insulation, door, fenestration product, or any other appliance, device, equipment, or system subject to Sections 110.0 through 110.9 of Part 6.

MECHANICAL COOLING is lowering the temperature within a space using refrigerant compressors or absorbers, desiccant dehumidifiers or other systems that require energy to directly condition the space. Systems that are solely energy recovery ventilation (ERV)

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or heat recovery ventilation (HRV) are not considered mechanical cooling. In nonresidential, multifamily buildings and hotel/motel buildings, cooling of a space by direct or indirect evaporation of water alone is not considered mechanical cooling.

MECHANICAL HEATING is raising the temperature within a space using electric resistance heaters, fossil fuel burners, heat pumps or other systems that require energy to directly condition the space. Systems that only use solar energy or heat recovery as the heat source are not mechanical heating systems.

MERV is the minimum efficiency reporting value as determined by ASHRAE Standard 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

METAL BUILDING is a complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal skin. This does not include structural glass or metal panels such as in a curtain-wall system.

MICROCHANNEL CONDENSER is an air-cooled condenser for refrigeration systems which utilizes multiple small parallel gas flow passages in a flat configuration with fin surfaces bonded between the parallel gas passages.

MINISPLIT AIR CONDITIONERS AND HEAT PUMPS are air conditioner or heat pump systems that have a single outdoor section and one or more indoor sections. The indoor sections cycle on and off in unison in response to a single indoor thermostat.

MODELING ASSUMPTIONS are the conditions (such as weather conditions, thermostat settings and schedules, internal gain schedules, etc.) that are used for calculating a building's annual energy consumption as specified in Section 10-109(c) and Section 10-116.

MULTIFAMILY BUILDING is any of the following:

A building of Occupancy Group R-2, other than a hotel/motel building or timeshare property,

A building of Occupancy Group R-3 that is a nontransient congregate residence, other than boarding houses of more than 6 guests and alcohol or drug abuse recovery homes of more than 6 guests, or

A building of Occupancy Group R-4.

MULTIPLE-SPLIT AIR CONDITIONERS AND HEAT PUMPS are air conditioner or heat pump systems that have two or more indoor sections. The indoor sections operate independently and can be used to condition multiple zones in response to multiple indoor thermostats.

MULTIPLE ZONE SYSTEM (or multi-zone system) is a space conditioning system that conditions more than one space conditioning zone, each of which has one or more devices (such as dampers, cooling coils and heating coils) that regulate airflow, cooling or heating capacity to the zone.

NATURAL GAS AVAILABILITY. For newly constructed buildings, natural gas is available if a gas service line can be connected to the site without a gas main extension. For addition and alteration, natural gas is available if a gas service line is connected to the existing building.

NEEA is the Northwest Energy Efficiency Alliance.

NEEA ADVANCED WATER HEATER SPECIFICATION is the Northwest Energy Efficiency Alliance (NEEA) specification version 8.1, effective date July 15, 2024, for heat pump water heaters.

NET EXHAUST FLOW RATE is the exhaust flow rate for a hood, minus any internal discharge makeup air flow rate.

NET FREE AREA (NFA) is the total unobstructed area within the air gaps between louver and grille slats in a vent, allowing the passage of air. The narrowest distance between two slats, perpendicular to the surface of both slats is the air gap height. The narrowest width of the gap is the air gap width. The NFA is the air gap height multiplied by the air gap width multiplied by the total number of air gaps between slats in the vent.

NET SENSIBLE COEFFICIENT OF PERFORMANCE (COP) is defined by AHRI 1360 and includes all indoor unit power and air-cooled condenser/condensing unit power for air-cooled units and includes all indoor unit power and the power allowance for pump and heat rejection as described in the Heat Rejection/Cooling Fluid Standard Rating Conditions table of AHRI 1360 for water, glycol and chilled water units.

NEWLY CONDITIONED SPACE is any space being converted from unconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See Section 141.0 for nonresidential occupancies and Section 150.2 for residential occupancies.

NEWLY CONSTRUCTED BUILDING is a building that has never been used or occupied for any purpose.

NONDUCTED SYSTEM is an air conditioner or heat pump that is permanently installed; directly heats or cools air within the conditioned space; and uses one or more indoor coils that are mounted on walls or ceilings within the conditioned space. The system may be of a modular design that allows for combining multiple outdoor coils and compressors to create one unified system.

NONRESIDENTIAL BUILDING is any building which is identified in the *California Building Code* Table; Description of Occupancy as Group A, B, E, F, H, I, L, M, or S, and is a U; as defined by Part 2 of Title 24 of the California Code or Regulation.

Note: Requirements for high-rise residential buildings and hotels/motels are included in the nonresidential sections of Part 6.

> **NONRESIDENTIAL BUILDING TYPES**

Assembly building is a building with meeting halls in which people gather for civic, social, or recreational activities. These include civic centers, convention centers and auditoriums.

Commercial and industrial storage building is a building with building floor areas used for storing items.

Events and exhibits building is a Museum Building, Motion Picture or Performance Arts Theater Building, or other building that is comprised of an Auditorium Area, Convention, Conference, Multipurpose and Meeting Area, or Civic Meeting Place Area.

Financial institution building is a building with floor areas used by an institution which collects funds from the public and places them in financial assets such as deposits, loans, and bonds.

Grocery store building is a building with building floor areas used for the display and sale of food.

Gymnasium building is a building with building floor areas used for physical exercises and recreational sport events and activities.

Industrial/manufacturing facility building is a building with building floor areas used for performing a craft, assembly or manufacturing operation.

Library building is a building with building floor areas used for repository of literary materials and for reading reference, such as books, periodicals, newspapers, pamphlets and prints.

Motion picture theater building is a building with building floor areas used for showing motion pictures to audiences.

Museum building is a building with building floor areas in which objects of historical, scientific, artistic or cultural interests are curated, treated, preserved, exhibited and stored.

Office building is a building of CBC Group B Occupancy with building floor areas in which business, clerical or professional activities are conducted.

Parking garage building is a building with building floor areas used for parking vehicles, and consists of at least a roof over the parking area enclosed with walls on all sides. The building includes areas for vehicle maneuvering to reach designated parking spaces. If the roof of a parking structure is also used for parking, the section without an overhead roof is considered an outdoor parking lot instead of a parking garage.

Performance arts theater building is a building with building floor areas used for showing performing arts that include plays, music or dance to audiences.

Religious worship building is a building that is comprised of a religious worship area.

Restaurant building is a building with building floor areas in which food and drink are prepared and served to customers in return for money.

Retail store building is a building with building floor areas used for the display and sale of merchandise except food.

School building is a building used by an educational institution. The building floor area can include classrooms or educational laboratories and may include an auditorium, gymnasium, kitchen, library, multipurpose room, cafeteria, student union or workroom. A maintenance or storage building is not a school building.

Sports arena building is a building with building floor areas used for public viewing of sporting events and activities. Sports arenas are classified according to the number of spectators they are able to accommodate, as follows:

Class I Facility is used for competition play for 5,000 or more spectators.

Class II Facility is used for competition play for up to 5,000 spectators.

Class III Facility is used for competition play for up to 2,000 spectators.

Class IV Facility is normally used for recreational play and there is limited or no provision for spectators.

Sports and recreation building is a building that is comprised of an Exercise/Fitness Center and Gymnasium Area, or other area where recreational sports are practiced.

Warehouse building is a building that is constructed for storage or handling of products.

NONRESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1(e) of the Public Resources Code, to aid designers, builders and contractors in meeting the energy efficiency requirements for nonresidential, high-rise residential and hotel/motel buildings.

NONRESIDENTIAL FUNCTION AREAS are those areas, rooms, and spaces within Nonresidential Buildings that fall within the following particular definitions and are defined according to the most specific definition.

Aisle way is the passage or walkway between storage racks permanently anchored to the floor in a Commercial or Industrial Storage Building, where the racks are used to store materials such as goods and merchandise.

Atrium is a large-volume indoor space created by openings between two or more stories but is not used for an enclosed stairway, elevator hoistway, escalator opening or utility shaft for plumbing, electrical, air-conditioning or other equipment.

Audience seating area is a room or area with fixed seats for public meetings or gatherings.

Auditorium area is a room or area with a stage and fixed seats used for public meetings or gatherings.

Auto repair/maintenance area is an area used to repair or maintain automotive equipment and/or vehicles.

Barber, beauty salon, spa area is a room or area in which the primary activity is manicures, pedicures, facials, or the cutting or styling of hair.

Civic meeting place area is a space in a government building designed or used for public debate, discussion or public meetings of governmental bodies.

Classroom, lecture, training, vocational area is a room or area where an audience or class receives instruction.

Commercial and industrial storage area (refrigerated) is a room or area used for storing items where mechanical refrigeration is used to maintain the space temperature at 55°F or less.

Convention, conference, multipurpose and meeting area are rooms or areas that are designed or used for meetings, conventions or events, and that have neither fixed seating nor fixed staging.

Copy room is a room or area used for copying, scanning, or binding documents.

Corridor area is a passageway or route into which compartments or rooms open.

Dining areas include the following:

Bar/lounge is a room or area where wait staff serve patrons with liquor, cocktails, wine and beer in a relaxed atmosphere, usually with tables and chairs.

Cafeteria/fast food is a room or area where customers pick up their food at a counter and there is little or no wait staff or table service.

Family dining is a room or area where wait staff serve patrons with meals in a casual atmosphere.

Fine dining is a room or area where wait staff serve patrons with meals in an elegant and formal atmosphere.

Electrical/mechanical/telephone room is a room in which the building's electrical switchbox or control panels, telephone switchbox, and/or HVAC controls or equipment is located.

Exercise/fitness center and gymnasium area is a room or area equipped for gymnastics, exercise equipment or indoor athletic activities.

Financial transaction area is a room or area used by an institution that collects funds from the public and places them in financial assets such as deposits, loans and bonds, and includes tellers, work stations and customers' waiting areas; to complete financial transactions. Financial transaction areas do not include private offices, hallways, restrooms or other support areas.

Healthcare facilities may have a room or area as follows:

Exam/treatment room is a room or area that does not provide overnight patient care and that is used to provide physical and mental care through medical, dental or psychological examination and treatment, including laboratories and treatment spaces.

Imaging room is a diagnostic room and area for application and review of results from imaging technologies including x-ray, ultrasound, computerized tomography (CT) and magnetic resonance imaging (MRI).

Medical supply room is a room or area used for storing medical supplies.

Nursery is a room or area for providing medical care for newly born infants.

Nurse's station is a room or area where health care staff work when not directly interacting with patients.

Operating room is a room or area where surgical operations are carried out in a sterile environment. This category also applies to veterinary operating rooms.

Patient room is a room or area that is occupied by one or more patients during a stay in a healthcare facility or hospital.

Physical therapy room is a room or area for providing physical therapy treatment.

Recovery room is a room or area that is equipped with apparatus for meeting postoperative emergencies and in which surgical patients are kept during the immediate postoperative period for care and recovery from anesthesia.

Hotel function area is a hotel room or area such as a hotel ballroom, meeting room, exhibit hall or conference room, together with prefunction areas and other spaces ancillary to its function.

Kitchen/food preparation area is a room or area with cooking facilities or where food is prepared. See "Kitchen" definitions for various kitchen types.

Laboratory is a space or room where hazardous materials are used for activities such as testing, analysis, instruction, research, or developmental activities.

Laboratory suite is a Group L occupancy space within a building or structure, which may include multiple laboratories, offices, storage, equipment rooms or similar support functions.

Laboratory, scientific area is a room or area where research, experiments, and measurement in medical and physical sciences are performed requiring examination of fine details. The area may include workbenches, countertops, scientific instruments, and associated floor spaces. Scientific laboratory does not refer to film, computer, and other laboratories where scientific experiments are not performed.

Laundry area is a room or area primarily designed or used for laundering activities.

Library area is a room or area primarily designed or used as a repository for literary materials such as books, periodicals, newspapers, pamphlets and prints, kept for reading or reference.

Reading area is a room or area in a library containing tables, chairs or desks for patrons to use for the purpose of reading books and other reference documents. Library reading areas include reading, circulation and checkout areas. Reading areas do not include private offices, meeting, photocopy or other rooms not used specifically for reading by library patrons.

Stack area is a room or area in a library with grouping of shelving sections. Stack aisles include pedestrian paths located in stack areas.

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Lobby, main entry is the contiguous area in buildings including hotel/motel that is directly located by the main entrance of the building through which persons must pass, including any ancillary reception, waiting and seating areas.

Locker room is a room or area for changing clothing, sometimes equipped with lockers.

Lounge/breakroom or waiting area is a room or area in which people sit, wait and relax.

Mall is a roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants.

Manufacturing, commercial and industrial work area is a room or area in which an art, craft, assembly or manufacturing operation is performed. Lighting installed in these areas is classified as follows:

High bay: Where the luminaires are 25 feet or more above the floor.

Low bay: Where the luminaires are less than 25 feet above the floor.

Precision: Where visual tasks of small size or fine detail such as electronic assembly, fine woodworking, metal lathe operation, fine hand painting and finishing, egg processing operations or tasks of similar visual difficulty are performed.

Multipurpose room is a room that can be used for multipurpose activities such as meetings, instructional activities and social gatherings. Multipurpose rooms are typically found in offices, schools, convention centers, and assisted living facilities.

Museum areas include the following:

Exhibit/display is a room or area in a museum that has for its primary purpose exhibitions, having neither fixed seating nor fixed staging. An exhibit does not include a gallery or other place where art is for sale. An exhibit does not include a lobby, conference room, or other occupancies where the primary function is not exhibitions.

Restoration room is a room or area in which the primary function is the care of works of artistic, historical or scientific value. A restoration does not include a gallery or other place where art is for sale. A restoration does not include a lobby, conference room or other occupancies where the primary function is not the care or exhibit of works of artistic, historical or scientific value.

Office area is a room or area in a building of CBC Group B Occupancy in which business, clerical or professional activities are conducted.

Parking garage areas include the following:

Daylight adaptation zone in a parking garage is the interior path of travel for vehicles adjacent to the entrance or exit of a parking garage as needed for visual adaptation to transition from exterior daylight levels to interior light levels. Daylight adaptation zones only include the path of vehicular travel and do not include adjacent parking areas.

Parking zones and ramps in a parking garage are used for the purpose of parking and maneuvering of vehicles. Parking areas include sloping floors of a parking garage, ramps and driveways specifically for the purpose of moving vehicles between floors of a parking garage. Parking areas and ramps do not include daylight adaptation zones or the roof of a parking garage, which may be present in a parking garage.

Pharmacy area is a room or area where medicinal drugs are dispensed and sold, usually in a retail store.

Playing area for sports arena is an area where sports are played in front an audience.

Religious worship area is a room or area in which the primary function is for an assembly of people to worship. Religious worship does not include classrooms, offices or other areas in which the primary function is not for an assembly of people to worship.

Restroom is a room providing personal facilities such as toilets and washbasins.

Retail sales areas include the following:

Fitting room is a room or area where the retail customers try out clothing before purchasing.

Grocery sales is a room or area that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Retail merchandise sales is a room or area in which the primary activity is the sale of merchandise.

Server room is a room smaller than 500 square feet, within a larger building, in which networking equipment and Information Technology (IT) server equipment is housed, and a minimum of five IT servers are installed in frame racks.

Server aisle is an aisle of racks of Information Technology (IT) server equipment in a Server Room. While networking equipment may also be housed on these racks, it is largely a room to manage server equipment.

Stairs is a series of steps providing passage for persons from one level of a building to another, including escalators.

Stairwell is a vertical shaft in which stairs are located.

Storage, commercial and industrial area includes the following:

Shipping & Handling is a room or areas used for packing, wrapping, labeling and shipping out goods, merchandise and materials.

Warehouse is a room or areas used for storing of items such as goods, merchandise and materials.

Support area is a room or area used as a passageway, utility room, storage space or other type of space associated with or secondary to the function of an occupancy that is listed in these regulations.

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Tenant lease area is a room or area in a building intended for lease for which a specific tenant is not identified at the time of building permit application.

Theater areas include the following:

Motion picture theater is an assembly room or area with rows of seats for the showing of motion pictures.

Performance theater is an assembly room or area with rows of seats for the viewing of dramatic performances, lectures, musical events and similar live performances.

Transportation function areas include the following:

Baggage area is a room or area in a transportation facility such as an airport where the travelers reclaim their baggage.

Ticketing area is a room or area in a transportation facility such as an airport or a train station where travelers purchase tickets, check in baggage, or inquire about travel information.

Videoconferencing studio is a room or area with permanently installed videoconferencing cameras, audio equipment and playback equipment for both audio-based and video-based two-way communication between local and remote sites.

NONSTANDARD PART LOAD VALUE (NPLV) is a single-number part-load efficiency figure of merit for chillers referenced to conditions other than IPLV conditions. (See "integrated part load value.")

NORTH-FACING (See "orientation.")

OCCUPANCY is the purpose for which a building or part thereof is used or intended to be used.

OCCUPANCY, HUMAN is any occupancy that is intended primarily for human activities.

OCCUPANCY GROUP is a classification of occupancy defined in Chapter 3 of the CBC (Title 24, Part 2).

OCCUPANCY TYPE is a description of occupancy that is more specific than occupancy group and that relates to determining the amount of lighting, ventilation, or other services needed for that portion of the building.

OCCUPIABLE SPACE is any enclosed space that is intended for human occupancy, including all habitable spaces as well as bathrooms, toilets, closets, halls, storage and utility areas, laundry areas, and similar areas. (See also "habitable space.")

OCCUPIED STANDBY MODE is when a zone is scheduled to be occupied and an occupant sensor indicates zero population within the zone.

ONLINE CAPACITY is the total combined capacity in actual cubic feet per minute of compressed air at a given pressure from all online compressors.

ONLINE COMPRESSORS are all the compressors that are physically connected to compressed air piping and are available to serve peak load. Online compressors do not include back up compressors whose only purpose is to be available when an online compressor fails.

OPEN COOLING TOWER, or OPEN-CIRCUIT COOLING TOWER is an open, or direct contact, cooling tower which exposes water directly to the cooling atmosphere, thereby transferring the source heat load from the water directly to the air by a combination of heat and mass transfer.

OPENADR 2.0a is the OpenADR Alliance document titled "OpenADR 2.0 Profile Specification A Profile," 2011.

OPENADR 2.0b is the OpenADR Alliance document titled "OpenADR 2.0 Profile Specification B Profile," 2015.

OPENADR 3.0, BASELINE PROFILE is the specific baseline profile defined in the OpenADR Alliance document titled, "OpenADR 3.0 Specification," 2023.

OPERABLE FENESTRATION is designed to be opened or closed.

OPTIMUM START CONTROLS are controls that are designed to automatically adjust the start time of a space-conditioning system each day with the intent of bringing the space to desired occupied temperature levels at the beginning of scheduled occupancy.

OPTIMUM STOP CONTROLS are controls that are designed to setup or setback thermostat setpoints before scheduled unoccupied periods based upon the thermal lag and acceptable drift in space temperature that is within comfort limits.

OSHPD is the California Office of Statewide Hospital Planning and Development.

ORIENTATION, CARDINAL is one of the four principal directional indicators, north, east, south and west, which are marked on a compass. Also called cardinal directions.

ORIENTATION, EAST-FACING is oriented to within 45 degrees of true east, including 45°00'00" south of east (SE), but excluding 45°00'00" north of east (NE).

ORIENTATION, NORTH-FACING is oriented to within 45 degrees of true north, including 45°00'00" east of north (NE), but excluding 45°00'00" west of north (NW).

ORIENTATION, SOUTH-FACING is oriented to within 45 degrees of true south including 45°00'00" west of south (SW), but excluding 45°00'00" east of south (SE).

ORIENTATION, WEST-FACING is oriented to within 45 degrees of true west, including 45°00'00" north of due west (NW), but excluding 45°00'00" south of west (SW).

OUTDOOR AIR (Outside air) is air taken from outdoors and not previously circulated in the building.

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OUTDOOR AREAS are areas external to a building. These include but are not limited to the following areas:

Building entrance way is the external area of any operable doorway in or out of a building, including overhead doors. These areas serve any doorway, set of doors (including elevator doors such as in parking garages), turnstile, vestibule or other form of portal that is ordinarily used to gain access to the building by its users and occupants. Where buildings have separate one-way doors to enter and to leave, this also includes any area serving any doors ordinarily used to leave the building.

Building façade is the exterior surfaces of a building, not including horizontal roofing, signs and surfaces not visible from any public accessible viewing location.

Canopy is a permanent structure, other than a parking garage area, consisting of a roof and supporting building elements, with the area beneath at least partially open to the elements. A canopy may be freestanding or attached to surrounding structures. A canopy roof may serve as the floor of a structure above.

Carport is a covered, open-sided structure designed or used primarily for the purpose of parking vehicles, having a roof over the parking area. Typically, carports are free-standing or projected from the side of the building and are only two or fewer car lengths deep. A "Carport" is not a "Garage."

Hardscape is the area of an improvement to a site that is paved or has other structural features such as curbs, plazas, entries, parking lots, site roadways, driveways, walkways, sidewalks, bikeways, water features and pools, storage or service yards, loading docks, amphitheaters, outdoor sales lots, and private monuments and statuary.

Outdoor sales canopy is a canopy specifically to cover and protect an outdoor sales area.

Outdoor sales frontage is the portion of the perimeter of an outdoor sales area immediately adjacent to a public street, road or sidewalk.

Outdoor sales lot is an uncovered paved area used exclusively for the display of vehicles, equipment or other merchandise for sale. All internal and adjacent access drives, walkway areas, employee and customer parking areas, vehicle service or storage areas are not outdoor sales lot areas, but are considered hardscape.

Parking lot is an uncovered area for the purpose of parking vehicles. Parking lot is a type of hardscape.

Paved area is an area that is paved with concrete, asphalt, stone, brick, gravel or other improved wearing surface, including the curb.

Principal viewing location is anywhere along the adjacent highway, street, road or sidewalk running parallel to an outdoor sales frontage.

Public monuments are statuary, buildings, structures and/or hardscape on public land.

Stairways and ramps. Stairways are one or more flights of stairs with the necessary landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another. An exterior stairway is open on at least one side, except for required structural columns, beams, handrails and guards. The adjoining open areas shall be either yards, courts or public ways. The other sides of the exterior stairway need not be open. Ramps are walking surfaces with a slope steeper than 5 percent.

Vehicle service station is a gasoline, natural gas, diesel or other fuel dispensing station.

OUTDOOR LIGHTING is electrical lighting used to illuminate outdoor areas.

OUTDOOR LIGHTING ZONE is a geographic area designated by the California Energy Commission in accordance with Part 1, Section 10-114, that determines requirements for outdoor lighting, including lighting power densities and specific control, equipment or performance requirements. Lighting zones are numbered LZ0, LZ1, LZ2, LZ3 and LZ4.

OVERHANG is a contiguous opaque surface, oriented horizontally and projecting outward horizontally from an exterior vertical surface.

PART 1 means Part 1 of Title 24 of the California Code of Regulations.

PART 6 means Part 6 of Title 24 of the California Code of Regulations.

PART-LOAD OPERATION occurs when a system or device is operating below its maximum rated capacity.

PARTICLE SIZE EFFICIENCY is the fraction (percentage) of particles that are captured on air filter equipment as determined during rating tests conducted in accordance with ASHRAE Standard 52.2 or AHRI Standard 680. Particle Size Efficiency is measured in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 microns.

PHOTOSYNTHETIC PHOTON EFFICACY (PPE) is photosynthetic photon flux divided by input electric power in units of micromoles per second per watt, or micromoles per joule as defined by ANSI/ASABE S640.

PHOTOSYNTHETIC PHOTON FLUX (PPF) is the rate of flow of photons between 400 to 700 nanometers in wavelength from a radiation source as defined by ANSI/ASABE S640.

POOL, PUBLIC is a pool other than a residential pool that is intended to be used for swimming or bathing and is operated by an owner, lessee, operator, licensee, or concessionaire, regardless of whether a fee is charged for use. Public pools include pools installed in private settings, such as multifamily residential buildings or hotels that are available exclusively for use by tenants or guests.

POOL PUMP, DEDICATED-PURPOSE refers to a category of pumps designed specifically for various pool related functions. This includes self-priming pool filter pumps, non-self-priming pool filter pumps, waterfall pumps, pressure cleaner booster pumps, integral sand-filter pool pumps, integral-cartridge filter pool pumps, storable electric spa pumps, and rigid electric spa pumps, as defined by 20 CCR §1602(g)(4).

POOLS are any structures or products intended for swimming, bathing or wading; designed and manufactured to be connected to a circulation system; and not intended to be drained and filled with each use. This includes, but is not limited to, in-ground, above-ground and on-ground pools; and wading pools.

POOLS, AUXILIARY POOL LOADS are features or devices that circulate pool water in addition to that required for pool filtration, including, but not limited to, solar pool heating systems, filter backwashing, pool cleaners, waterfalls, fountains and spas.

POOLS, BACKWASH VALVE is a diverter valve designed to backwash filters located between the circulation pump and the filter, including, but not limited to, slide, push-pull, multiport and full-flow valves.

POOLS, MULTISPEED PUMP is a pump capable of operating at two or more speeds and includes two-speed and variable-speed pumps.

POOLS, NSF/ANSI/CAN 50 is the NSF International (formerly National Sanitation Foundation) Standard and American National Standards Institute document entitled "Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs, and Other Recreational Water Facilities," 2020 (NSF/ANSI/CAN 50—2020).

POOLS, RESIDENTIAL is a pool intended for use that is accessory to a residential setting and available only to the household and its guests, and with specifications as defined within the scope of either ANSI/APSP/ICC-4, 2012 (R2022) or ANSI/APSP/ICC-5, 2011 (R2022).

PORTABLE ELECTRIC SPA is a factory-built electric spa or hot tub, supplied with equipment for heating and circulating water at the time of sale or sold separately for subsequent attachment, as defined by 20 CCR §1602(g)(2).

POWER CONDITIONING SYSTEM (PCS) is a device, which may be either integrated into a Battery Energy Storage System (BESS) or standalone, that allows for the BESS to interact with other electrical infrastructure, such as the electrical network. The PCS may include an inverter like that used for a photovoltaic (PV) system.

PRESSURE BOUNDARY is the primary air enclosure boundary separating indoor and outdoor air. For example, a volume that has more leakage to the outside than to the conditioned space would be considered outside the pressure boundary. Exposed earth in a crawlspace or basement shall not be considered part of the pressure boundary.

PRIMARY AIRFLOW is the airflow (cfm or L/s) supplied to the zone from the air-handling unit at which the outdoor air intake is located. It includes outdoor intake air and recirculated air from that air-handling unit but does not include air transferred or air recirculated to the zone by other means.

PRIMARY STORAGE is compressed air storage located upstream of the distribution system and any pressure flow regulators.

PROCESS is an activity or treatment that is not related to the space conditioning, lighting, service water heating or ventilating of a building as it relates to human occupancy.

PROCESS BOILER is a type of boiler with a capacity (rated maximum input) of 300,000 Btus per hour (Btu/h) or more that serves a process.

> **PROCESS, COVERED** is a process that includes computer rooms, data centers, elevators, escalators and moving walkways, laboratories, enclosed parking garages, commercial kitchens, refrigerated warehouses, commercial refrigeration, compressed air systems, process boilers process heating and cooling piping, and controlled environment horticultural spaces.

PROCESS, NON-COVERED is a process that is not a covered process regulated under Part 6.

PROCESS LOAD is an energy load resulting from a process.

PROCESS SPACE is a nonresidential space that is designed to be thermostatically controlled to maintain a process environment temperature less than 55°F or to maintain a process environment temperature greater than 90°F for the whole space that the system serves, or that is a space with a space-conditioning system designed and controlled to be incapable of operating at temperatures above 55°F or incapable of operating at temperatures below 90°F at design conditions.

PROGRAMMING LIBRARY is a collection of programming logic used for controlling HVAC equipment with direct digital control systems.

PROPOSED DESIGN BUILDING is a building that is simulated by Commission-approved compliance software to determine the energy consumption resulting from all of the characteristics and energy consuming features that are actually proposed for a building, as specified by Section 10-109(c) and Section 10-116.

PUBLIC AREAS are spaces generally open to the public at large, customers or congregation members, or similar spaces where occupants need to be prevented from controlling lights for safety, security or business reasons.

***R*-VALUE** is the measure of the thermal resistance of insulation or any material or building component expressed in ft^2-hr-°F/Btu.

RADIANT BARRIER is a highly reflective, low emitting material installed at the underside surface of the roof deck and the inside surface of gable ends or other exterior vertical surfaces in attics to reduce solar heat gain.

RAISED FLOOR is a floor (partition) over a crawl space, or an unconditioned space, or ambient air.

READILY ACCESSIBLE is capable of being reached quickly for operation, repair or inspection, without requiring climbing or removing obstacles, or resorting to access equipment.

RECOOL is the cooling of air that has been previously heated by space-conditioning equipment or systems serving the same building.

RECOVERED ENERGY is energy used in a building that (1) is recovered from space conditioning, service water heating, lighting, or process equipment after the energy has performed its original function; (2) provides space conditioning, service water heating, or lighting; and (3) would otherwise be wasted.

RECOVERED ENERGY, ON-SITE is recovered energy that is captured at the building site.

REFERENCE APPENDICES is the support document for the Building Energy Efficiency Standards. The document consists of three sections: the Reference Joint Appendices (JA), the Reference Residential Appendices (RA) and the Reference Nonresidential Appendices (NA).

REFLECTANCE, SOLAR is the ratio of the reflected solar flux to the incident solar flux.

REFRIGERATED CASE is a manufactured commercial refrigerator or freezer, including but not limited to display cases, reach-in cabinets, meat cases, and frozen food and soda fountain units.

REFRIGERATED SPACE is a space constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at 55°F or less.

REFRIGERATED WAREHOUSE is a building or a space greater than or equal to 3,000 square feet constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at 55°F or less.

REHEAT is the heating of air that has been previously cooled by cooling equipment or supplied by an economizer.

RELOCATABLE PUBLIC SCHOOL BUILDING is a relocatable building as defined by Title 24, Part 1, Section 4-314, which is subject to Title 24, Part 1, Chapter 4, Group 1.

REPAIR is the reconstruction or renewal for the purpose of maintenance of any component, system or equipment of an existing building. Repairs shall not increase the preexisting energy consumption of the repaired component, system or equipment. Replacement of any component, system or equipment for which there are requirements in the Standards is considered an alteration and not a repair.

RESIDENTIAL BUILDING (See "High-rise residential building" and "Low-rise residential building.")

RESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1 of the Public Resources Code, to aid designers, builders and contractors in meeting energy efficiency standards for low-rise residential buildings.

RESIDENTIAL SPACE TYPE is one of the following:

Bathroom is a room or area containing a sink used for personal hygiene, toilet, shower or a tub.

Closet is a nonhabitable room used for the storage of linens, household supplies, clothing, nonperishable food or similar uses, and which is not a hallway or passageway.

Garage is a nonhabitable building or portion of building, attached to or detached from a residential dwelling unit, in which motor vehicles are parked.

Kitchen is a room or area used for cooking, food storage and preparation and washing dishes, including associated counter tops and cabinets, refrigerator, stove, ovens and floor area.

Laundry is a nonhabitable room or space which contains plumbing and electrical connections for a washing machine or clothes dryer.

Storage building is a nonhabitable detached building used for the storage of tools, garden equipment or miscellaneous items.

Utility room is a nonhabitable room or building which contains only HVAC, plumbing, or electrical controls or equipment; and which is not a bathroom, closet, garage or laundry room.

RESNET 380 is the Residential Energy Services Network document titled "Standard for Testing Airtightness of Building Enclosures, Dwelling Unit, and Sleeping Unit Enclosures, Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems," 2019 (ANSI/RESNET/ICC 380-2019).

ROOF is the outside cover of a building or structure including the structural supports, decking and top layer that is exposed to the outside with a slope less than 60 degrees from the horizontal.

ROOF, LOW-SLOPED is a roof that has a ratio of rise to run of less than 2:12 (9.5 degrees from the horizontal).

ROOF, STEEP-SLOPED is a roof that has a ratio of rise to run of greater than or equal to 2:12 (9.5 degrees from the horizontal).

ROOF RECOVER is the process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

ROOF RECOVER BOARD is a rigid type board installed directly below a low-sloped roof membrane, with or without above deck thermal insulation, to: (a) improve a roof system's compressive strength, (b) physically separate the roof membrane from the thermal insulation, or (c) physically separate a new roof covering from an underlying roof membrane as part of a roof overlay project.

ROOF REPLACEMENT is the process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

ROOFING PRODUCT is the top layer of the roof that is exposed to the outside, which has properties including but not limited to solar reflectance, thermal emittance and mass.

RUNOUT is piping that is no more than 12 feet long and that connects to a fixture or an individual terminal unit.

SAE J1772 is the SAE International document titled "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler" (SAE J1772_201710).

SATURATED CONDENSING TEMPERATURE (also known as CONDENSING TEMPERATURE) is: (a) for single component and azeotropic refrigerants, the saturation temperature corresponding to the refrigerant pressure at the condenser entrance, or (b) for

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zeotropic refrigerants, the arithmetic average of the Dew Point and Bubble Point temperatures corresponding to the refrigerant pressure at the condenser entrance.

SCIENTIFIC EQUIPMENT is measurement, testing or metering equipment used for scientific research or investigation, including but not limited to manufactured cabinets, carts and racks.

SEAL CLASS A is a ductwork sealing category that requires sealing all transverse joints, longitudinal seams and duct wall penetrations. Duct wall penetrations are openings made by pipes, conduit, tie rods or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels and duct connections to equipment. Sealing that would void product listings is not required. All duct pressure class ratings shall be designated in the design documents.

SEASONAL ENERGY EFFICIENCY RATIO (SEER) is the total cooling output of an air conditioner in Btu during its normal usage period for cooling divided by the total electrical energy input in watt-hours during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

SEASONAL ENERGY EFFICIENCY RATIO 2 (SEER2) is the SEER metric for residential central air conditioners and heat pumps effective January 1, 2023, as created by the U.S. Department of Energy "ISSUANCE 2016-11-30 Energy Conservation Program: Test Procedures for Central Air Conditioners and Heat Pumps, Final Rule."

SELF-UTILIZATION CREDIT is the limited efficiency LSC energy budget compliance credit available for combined PV and battery energy storage systems for single-family, as specified by the Residential ACM Reference Manual, and low-rise multifamily, as specified by the Nonresidential and Multifamily ACM Reference Manual.

SENSIBLE ENERGY RECOVERY RATIO is a ratio of the change in the dry-bulb temperature of the outdoor air supply to the difference in dry-bulb temperature between the outdoor air and entering exhaust airflow, with no adjustment to account for that portion of the dry-bulb temperature change in the leaving supply airflow that is the result of leakage of entering exhaust airflow rather than heat exchange between the airstreams.

SERVICE WATER HEATING is heating of water for sanitary purposes for human occupancy, other than for comfort heating.

SHADING is the protection from heat gains because of direct solar radiation by permanently attached exterior devices or building elements, interior shading devices, glazing material or adherent materials.

SHADING COEFFICIENT(SC) is the ratio of the solar heat gain through a fenestration product to the solar heat gain through an unshaded $^{1}/_{8}$-inch-thick clear double strength glass under the same set of conditions. For nonresidential, high-rise residential and hotel/motel buildings, this shall exclude the effects of mullions, frames, sashes, and interior and exterior shading devices.

SIDELIT DAYLIT ZONE, PRIMARY is the area in plan view directly adjacent to each vertical glazing, one window head height deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

SIDELIT DAYLIT ZONE, SECONDARY is the area in plan view directly adjacent to each vertical glazing, two window head heights deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

SIGN definitions include the following:

Electronic message center (EMC) is a pixelated image producing electronically controlled sign formed by any light source. Bare lamps used to create linear lighting animation sequences through the use of chaser circuits, also known as "chaser lights" are not considered an EMC.

Illuminated face is a side of a sign that has the message on it. For an exit sign it is the side that has the word "EXIT" on it.

Sign, cabinet is an internally illuminated sign consisting of frame and face, with a continuous translucent message panel, also referred to as a panel sign.

Sign, channel letter is an internally illuminated sign with multiple components, each built in the shape of an individual three-dimensional letter or symbol that are each independently illuminated, with a separate translucent panel over the light source for each element.

Sign, double-faced is a sign with two parallel opposing faces.

Sign, externally illuminated is any sign or a billboard that is lit by a light source that is external to the sign directed towards and shining on the face of the sign.

Sign, internally illuminated is a sign that is illuminated by a light source that is contained inside the sign where the message area is luminous, including cabinet signs and channel letter signs.

Sign, traffic is a sign for traffic direction, warning and roadway identification.

Sign, unfiltered is a sign where the viewer perceives the light source directly as the message, without any colored filter between the viewer and the light source, including neon, cold cathode and LED signs.

SIMULTANEOUS MECHANICAL HEAT RECOVERY is the simultaneous utilization of heat rejected from mechanical cooling for space heating or water heating.

SINGLE FAMILY BUILDING is any of the following:

A residential building of Occupancy Group R-3 with two or fewer dwelling units,

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A building of Occupancy Group R-3, other than a multifamily building or hotel/motel building,

A townhouse,

A building of Occupancy Group R-3.1 or

A building of Occupancy Group U when located on a residential site.

SINGLE PACKAGE VERTICAL AIR CONDITIONER (SPVAC) is a type of air-cooled small or large commercial package air-conditioning and heating equipment; factory assembled as a single package having its major components arranged vertically, which is an encased combination of cooling and optional heating components; is intended for exterior mounting on, adjacent interior to, or through an outside wall; and is powered by single or three-phase current. It may contain separate indoor grille, outdoor louvers, various ventilation options, indoor free air discharge, ductwork, wall plenum or sleeve. Heating components may include electrical resistance, steam, hot water, gas, or no heat but may not include reverse cycle refrigeration as a heating means.

SINGLE PACKAGE VERTICAL HEAT PUMP (SPVHP) is an SPVAC that utilizes reverse cycle refrigeration as its primary heat source, with secondary supplemental heating by means of electrical resistance, steam, hot water or gas.

SINGLE ZONE CONSTANT VOLUME HEAT PUMP (SZHP) is an air-source heat pump that uses a supply fan with a speed that does not vary.

SINGLE ZONE SYSTEM is an air distribution system that supplies air to one thermal zone controlled by a single thermostat.

SITE SOLAR ENERGY is thermal, chemical or electrical energy derived from direct conversion of incident solar radiation at the building site.

SKYLIGHT is fenestration installed on a roof less than 60 degrees from the horizontal.

SKYLIGHT AREA is the area of the rough opening for the skylight.

SKYLIGHT TYPE is one of the following three types of skylights: glass mounted on a curb, glass not mounted on a curb, or plastic (assumed to be mounted on a curb).

SKYLIT DAYLIT ZONE is the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one-half of the distance from the floor to the bottom of the skylight. The bottom of the skylight is measured from the bottom of the skylight well for skylights having wells, or the bottom of the skylight if no skylight well exists. For the purpose of determining the skylit daylit zone, the geometric shape of the skylit daylit zone shall be identical to the plan view geometric shape of the rough opening of the skylight; for example, for a rectangular skylight the skylit daylit zone plan area shall be rectangular, and for a circular skylight the skylit daylit zone plan area shall be circular. For skylight located in an atrium, the skylit daylit zone shall include the floor area directly under the atrium, and the area of the top floor that is directly under the skylight, plus 0.7 times the average ceiling height of the top floor, in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one-half of the distance from the top floor to the bottom of the skylight.

SMACNA is the Sheet Metal and Air-conditioning Contractors National Association.

SMACNA HVAC DUCT CONSTRUCTION STANDARDS is the Sheet Metal Contractors' National Association document "HVAC Duct Construction Standards Metal and Flexible - 3rd Edition," 2006 (2006 ANSI/SMACNA- 006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition).

SMACNA RESIDENTIAL COMFORT SYSTEM INSTALLATION STANDARDS is the Sheet Metal Contractors' National Association document entitled "Residential Comfort System Installation Standards, Eighth Edition," (2016).

SOCIAL SERVICES BUILDING is a space where public assistance and social services are provided to individuals or families.

SOLAR ELECTRIC GENERATION SYSTEM or PHOTOVOLTAIC SYSTEM is the complete set of all components for converting sunlight into electricity through the photovoltaic process, including the array of panels, inverter(s) and the balance of system components required to enable the system to effectively deliver power to reduce a building's consumption of electricity from the utility grid.

SOLAR POOL HEATING SYSTEM is an assembly of components designed to heat water for swimming pools, spas or swimming pool and spa combinations by solar thermal means, excluding pool recirculation components.

SOLAR REFLECTANCE INDEX (SRI) is a measure of the roof's ability to reject solar heat, which includes both reflectance and emittance.

SOLAR SAVINGS FRACTION (SSF) is the fraction of domestic hot water demand provided by a solar water-heating system.

SOLAR ZONE is a section of the roof designated and reserved for the future installation of a solar electric or solar thermal system.

SOURCE ENERGY is defined as the long run hourly marginal source energy of fossil fuels that are combusted as a result of building energy consumption either directly at the building site or caused to be consumed to meet the electrical demand of the building considering the long-term effects of Commission-projected energy resource procurement. For a given hour, the value in that hour for each forecasted year is averaged to establish a lifetime average source energy.

SOUTH-FACING (See "orientation.")

SPA is a vessel that contains heated water in which humans can immerse themselves, is not a pool, and is not a bathtub.

SPACE-CONDITIONING SYSTEM is a system that provides mechanical heating or mechanical cooling within or associated with conditioned spaces in a building, and may incorporate use of components such as chillers/compressors, fluid distribution systems (e.g., air ducts, water piping, refrigerant piping), pumps, air handlers, cooling and heating coils, air or water cooled condensers, economizers, terminal units, and associated controls.

STANDARD DESIGN BUILDING is a building that is automatically simulated by Commission-approved compliance software to establish the energy budget that is the maximum energy consumption allowed by a proposed design building to comply with the Title 24 Building Energy Efficiency Standards. The standard design building is simulated using the same location and having the same characteristics of the proposed design building, but assuming minimal compliance with the mandatory and prescriptive requirements that are applicable to the proposed building, as specified by Section 10-109(c) and Section 10-116.

STORAGE, COLD is a storage area within a refrigerated warehouse where space temperatures are maintained at or above 32°F.

STORAGE, FROZEN is a storage area within a refrigerated warehouse where the space temperatures are maintained below 32°F.

TENANT SPACE is a portion of a building occupied by a tenant.

THERMAL MASS is solid or liquid material with a high overall heat capacity to store energy for heating or cooling requirements.

THERMAL RESISTANCE (R) is a measurement of the resistance over time of a material or building component to the passage of heat in (hr × ft^2 × °F)/Btu.

THERMOSTAT is an automatic control device or system used to maintain temperature at a fixed or adjustable setpoint.

THERMOSTATIC EXPANSION VALVE (TXV) is a refrigerant metering valve, installed in an air conditioner or heat pump, which controls the flow of liquid refrigerant entering the evaporator in response to the superheat of the gas leaving it.

TOTAL HEAT OF REJECTION (THR) is the heat rejected by refrigeration system compressors at design conditions, consisting of the design cooling capacity plus the heat of compression added by the compressors.

TOWNHOUSE is a single-family dwelling unit constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on at least two sides.

TRANSCRITICAL CO_2 REFRIGERATION SYSTEM is a type of refrigeration system that uses CO_2 as the refrigerant where the ultimate heat rejection to ambient air can take place above the critical point.

SUBCRITICAL MODE is a system operating condition for a refrigeration system wherein the refrigerant pressure and temperature leaving the compressor is such that the refrigerant is below the critical point. Typically used in reference to CO_2 refrigeration systems.

TRANSCRITICAL MODE is a system operating condition for a refrigeration system wherein the refrigerant pressure and temperature leaving the compressor is such that the refrigerant is at or above the critical point. Typically used in reference to CO_2 refrigeration systems.

TRANSIENT is the occupancy for not more than 30 days of a dwelling unit or sleeping unit.

TRIM COMPRESSOR is a compressor that is designated for part-load operation, handling the short-term variable trim load of end uses, in addition to the fully loaded base compressors.

***U*-FACTOR** is the overall coefficient of thermal transmittance of a fenestration, wall, floor, roof or ceiling component in Btu/(hr × ft^2 × °F), including air film resistance at both surfaces.

UL is the Underwriters Laboratories.

UL 181 is the Underwriters Laboratories document titled "Standard for Safety for Factory-Made Air Ducts and Air Connectors," 2017 (UL 181).

UL 181A is the Underwriters Laboratories document titled "Standard for Safety for Closure Systems for Use with Rigid Air Ducts," 2017 (UL 181A).

UL 181B is the Underwriters Laboratories document titled "Standard for Safety for Closure Systems for Use with Flexible Air Ducts and Air Connectors," 2017 (UL 181B).

UL 723 is the Underwriters Laboratories document titled "Standard for Safety for Test for Surface Burning Characteristics," 2018 (UL 723).

UL 727 is the Underwriters Laboratories document entitled "Standard for Safety for Oil-Fired Central Furnaces," 2018 (UL 727).

UL 731 is the Underwriters Laboratories document entitled "Standard for Safety for Oil-Fired Unit Heaters," 2018 (UL 731).

UL 1077 is the Underwriters Laboratories document titled "Standard for Safety for Supplementary Protectors for Use in Electrical Equipment," 2016 (UL 1077).

UL 1574 is the Underwriters Laboratories document entitled "Standard for Safety for Track Lighting Systems," 2020 (UL 1574).

UL 1598 is the Underwriters Laboratories document entitled "Standard for Safety for Luminaires," 2021 (UL 1598).

UL 1741 is the Underwriters Laboratories document titled "Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources," 2021 (UL 1741).

UL 1973 is the Underwriters Laboratories document titled "Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications," 2018 (ANSI/CAN/UL-1973:2018).

UL 2108 is the Underwriters Laboratories document titled "Standard for Safety for Low Voltage Lighting Systems," 2019 (UL 2108).

UL 8750 is the Underwriters Laboratories document titled "Standards for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products," 2021 (UL 8750).

UL 9540 is the Underwriters Laboratories document titled "Standard for Safety for Energy Storage Systems and Equipment," 2023 (ANSI/CAN/UL 9540:2023).

UNCONDITIONED SPACE is enclosed space within a building that is not directly conditioned or indirectly conditioned.

UNIFORM ENERGY FACTOR (UEF) of a water heater is a measure of overall water heater efficiency, as determined using the applicable test method in the Appliance Efficiency Regulations.

USDOE 10 CFR 430 is the regulation issued by Department of Energy and available in the Code of Federal Regulation -Title 10, Chapter II, Subchapter D, Part 430 – Energy Conservation Program for Consumer Products. Relevant testing methodologies are specified in applicable appendices.

USDOE 10 CFR 431 is the regulation issued by Department of Energy and available in the Code of Federal Regulation -Title 10, Chapter II, Subchapter D, Part 431 - Energy Conservation Program for Certain Commercial and Industrial equipment. Relevant testing methodologies are specified in "Subpart E to Part 431 – Uniform test method for the measurement of energy efficiency of commercial packaged boilers."

VAPOR RETARDER CLASS is a measure of the ability of a material or assembly to limit the amount of moisture that passes through the material or assembly meeting Section 202 of the *California Building Code.*

VARIABLE AIR VOLUME (VAV) SYSTEM is a space- conditioning system that maintains comfort levels by varying the volume of supply air to the zones served.

VENDING MACHINE is a machine for vending and dispensing refrigerated or nonrefrigerated food and beverages or general merchandise.

VENTILATION SYSTEM, BALANCED is at least one mechanical device intended to remove air from buildings, and simultaneously replace it with outdoor air.

VENTILATION SYSTEM, CENTRAL FAN INTEGRATED, or CFI is a ventilation system configuration in which the ventilation ductwork is connected to the duct system of a dwelling unit space-conditioning system to enable distribution of ventilation air to the dwelling unit while the space-conditioning system air handling unit is operating.

VENTILATION SYSTEM, ENERGY RECOVERY, or ERV is a mechanical device intended to remove air from buildings, simultaneously replace it with outdoor air, and in the process transfer heat from the warmer to the colder of the simultaneous airflows and transfer moisture from the most humid to least humid of the simultaneous airflows.

VENTILATION SYSTEM, EXHAUST is at least one mechanical device intended to remove air from buildings, causing outdoor air to enter by ventilation inlets or normal leakage paths through the building envelope.

VENTILATION SYSTEM, HEAT RECOVERY, or HRV is a mechanical device intended to remove air from buildings, simultaneously replace it with outdoor air, and in the process transfer heat from the warmer to the colder of the simultaneous airflows.

VENTILATION SYSTEM, SUPPLY is at least one mechanical device intended to bring outdoor air into buildings, causing indoor air to flow out of the building through ventilation relief outlets or normal leakage paths through the building envelope.

VERY VALUABLE MERCHANDISE are rare or precious objects, including, but not limited to, jewelry, coins, small art objects, crystal, ceramics or silver, the selling of which involves customer inspection of very fine detail from outside of a locked case.

VIRTUAL END NODE (VEN) is an interface with a demand responsive control system that accepts signals transmitted through OpenADR, consistent with the specifications in OpenADR 2.0a, 2.0b or Baseline Profile OpenADR 3.0.

WALL TYPE is a type of wall assembly having a specific heat capacity, framing type and *U*-factor.

WATER BALANCE IN EVAPORATIVE COOLING TOWERS. The water balance of a cooling tower is:

$M = E + B$, where:

M = makeup water (from the mains water supply)
E = losses due to evaporation
B = losses due to blowdown

WATER HEATER definitions include the following:

CONSUMER WATER HEATER is a water heater that meets the definition of a consumer product under USDOE 10 CFR 430.

HEAT PUMP WATER HEATER (HPWH) is a water heater that transfers thermal energy from one temperature level to another temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

INTEGRATED HEAT PUMP WATER HEATER is a HPWH that has all components, including fans, storage tanks, pumps, or controls necessary for the device to perform its function contained in a single factory-made assembly.

SPLIT-REFRIGERANT HEAT PUMP WATER HEATER is a HPWH that has a single outdoor section and one or more indoor sections connected to the outdoor section via a refrigerant circuit.

SPLIT-HYDRONIC HEAT PUMP WATER HEATER is a HPWH that consists of multiple separate sections. One section houses all the refrigerant components, while one or more additional sections are designated for water storage. These sections are interconnected through a hydronic circuit.

MULTI-PASS WATER HEATER is a water heater that the cold water passes through multiple times. The water temperature increases with each pass until the storage tank reaches the intended storage temperature.

SINGLE-PASS WATER HEATER is a water heater which the cold water passes through once and is heated to the intended use temperature.

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WEST-FACING (See "orientation.")

WINDOW FILM is a fenestration attachment product that consists of a flexible adhesive-backed polymer film, which may be applied to the interior or exterior surface of an existing glazing system.

WOOD HEATER is an enclosed wood-burning appliance used for space heating and/or domestic water heating.

WOOD STOVE (See "wood heater.")

ZONAL describes characterized by or relating to a zone or zones.

ZONE, CRITICAL is a zone serving a process where reset of the zone temperature setpoint during a demand shed event might disrupt the process, including but not limited to computer rooms, data centers, telecom and private branch exchange (PBX) rooms, and laboratories.

ZONE, NONCRITICAL is a zone that is not a critical zone.

ZONE, SPACE-CONDITIONING, is a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in Section 140.4(b)3 or 150.0(h), as applicable, can be maintained throughout the zone by a single controlling device.

SECTION 100.2—CALCULATION OF ENERGY BUDGETS

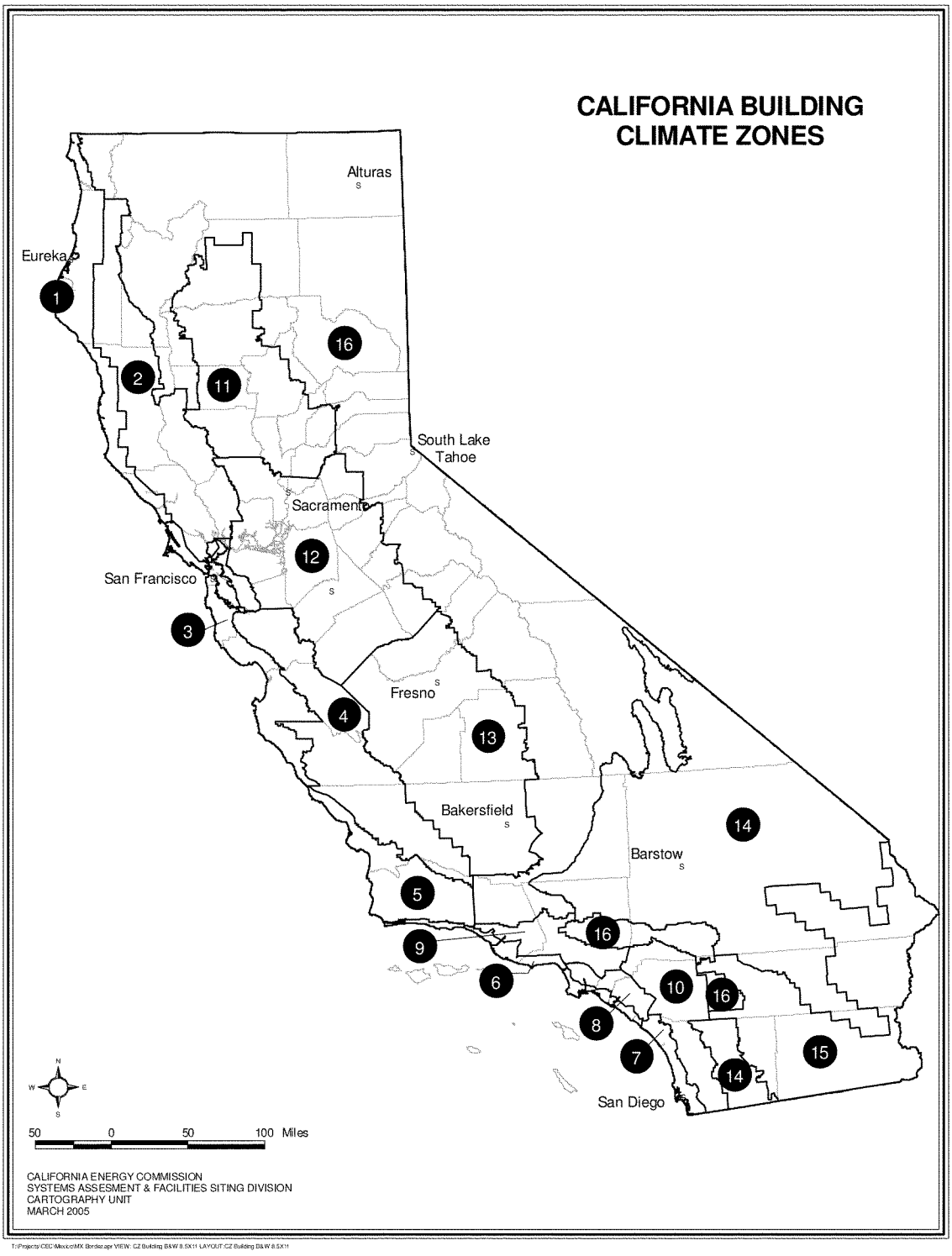
Energy budgets are adopted by the Commission to establish the maximum energy consumption that a proposed building, or portion of a building, can be designed to consume. A building complies with the performance standards compliance approach if the energy consumption calculated for the proposed design building is no greater than the energy budget calculated for the standard design building using Commission-certified compliance software as specified by the Alternative Calculation Methods Reference Manual. The energy budget for newly constructed single-family, multifamily, and nonresidential buildings are expressed in terms of Long-Term System Cost (LSC) and Source Energy. The energy budget for additions and alterations for all building types are expressed in terms of LSC.

Long-term System Cost (LSC) is calculated by multiplying for each hour of the year the site energy use (electricity kWh, natural gas therms, or fuel oil or LPG gallons) for each energy type by the applicable CEC-published LSC hourly factors. LSC hourly factors vary for each hour of the year and by energy type (electricity, natural gas, or propane), by Climate Zone and by building type (residential, nonresidential). LSC hourly factors are summarized in Reference Joint Appendix JA3. LSC hourly factors for propane are used for all energy obtained from depletable sources other than electricity and natural gas.

Source Energy is calculated by multiplying for each hour of the year the site energy use (electricity kWh, natural gas therms, or fuel oil or LPG gallons) by Btu factors for fossil fuel consumed either directly at the building site or caused to be consumed to meet the electrical demand of the building considering the long-term marginal hourly resources of Commission-projected electric system resource procurement.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

FIGURE 100.1-A CALIFORNIA CLIMATE ZONES
Climate Zones for Residential and Nonresidential Occupancies



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SUBCHAPTER

2

ALL OCCUPANCIES—MANDATORY REQUIREMENTS FOR THE MANUFACTURE, CONSTRUCTION AND INSTALLATION OF SYSTEMS, EQUIPMENT AND BUILDING COMPONENTS

SECTION 110.0—SYSTEMS AND EQUIPMENT—GENERAL

Sections 110.1 through 110.12 specify requirements for manufacturing, construction and installation of certain systems, equipment, appliances and building components that are installed in buildings within the scope of Section 100.0(a).

Note: The requirements of Sections 110.0 through 110.12 apply to newly constructed buildings. Sections 141.0 and 150.2 specify which requirements of Sections 110.1 through 110.12 also apply to additions and alterations to existing buildings.

(a) **General Requirements.** Systems, equipment, appliances and building components shall only be installed in a building within the scope of Section 100.0(a) regulated by Part 6 only if:

1. The manufacturer has certified that the system, equipment, appliances or building component complies with the applicable manufacturing provisions of Sections 110.1 through 110.12; and
2. The system, equipment, appliance or building component complies with all applicable installation provisions of Sections 110.1 through 110.12.

(b) **Certification Requirements for Manufactured Systems, Equipment, Appliances and Building Components.**

1. Appliances that are within the scope of Section 1601 of the Appliance Efficiency Regulations shall only be installed if they have been certified to the Energy Commission by the manufacturer, pursuant to the provisions of Title 20 California Code of Regulations, Section 1606; or
2. Systems, equipment, appliances and building components that are required by Part 6 or the Reference Appendices to be certified to the Energy Commission, which are not appliances that are within the scope of Section 1601 of the Appliance Efficiency Regulations, shall only be installed if they are certified by the manufacturer in a declaration, executed under penalty of perjury under the laws of the State of California, that:
   A. All the information provided pursuant to the certification is true, complete, accurate and in compliance with all applicable requirements of Part 6; and
   B. The equipment, product, or device was tested using the test procedure specified in Part 6 if applicable
3. The certification status of any system, equipment, appliance or building component shall be confirmed only by reference to:
   A. A directory published or approved by the Commission; or
   B. A copy of the application for certification from the manufacturer and the letter of acceptance from the Commission staff; or
   C. Written confirmation from the publisher of a Commission-approved directory that a device has been certified; or
   D. A Commission-approved label on the device.

Note: Part 6 does not require a builder, designer, owner, operator, or enforcing agency to test any certified device to determine its compliance with minimum specifications or efficiencies adopted by the Commission.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5,-25402.8, and 25943, *Public Resources Code.*

SECTION 110.1—MANDATORY REQUIREMENTS FOR APPLIANCES

(a) Any appliance regulated by the Appliance Efficiency Regulations, Title 20 California Code of Regulations, Section 1601 et seq., may be installed only if the appliance fully complies with Section 1608(a) of those regulations.

(b) Except for those circumstances described in Section 110.1(c), conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards shall be verified utilizing data from either:

1. The Energy Commission's database of certified appliances maintained pursuant to Title 20 California Code of Regulations Section 1606, and which is available at: www.energy.ca.gov/appliances/database/; or
2. An equivalent directory published by a federal agency; or
3. An approved trade association directory as defined in Title 20 California Code of Regulations Section 1606(h).

(c) Conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards shall be demonstrated either by default to the mandatory efficiency levels specified in Part 6 or by following procedures approved by the Commission pursuant to Section 10-109 of Title 24, Part 1, when:

1. Data to verify conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards is not available pursuant to subdivision (b); or
2. Field verification and diagnostic testing is required for compliance with Part 6 and the Energy Commission has not approved a field verification and diagnostic test protocol that is applicable to the appliance; or
3. The appliance meets the requirements of Section 110.1(a) but has been site-modified in a way that affects its performance; or

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4. The U.S. Department of Energy has approved a waiver from federal test procedures, pursuant to 10 CFR Section 430.27 or Section 431.401 and that waiver fails to specify how the efficiency of the system shall be determined.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5,-25402.8, and 25943, *Public Resources Code.*

SECTION 110.2—MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

Certification by manufacturers. Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified to the Commission that the equipment complies with all the applicable requirements of this section.

(a) **Efficiency.** Equipment shall meet the applicable efficiency requirements in Tables 110.2-A through 110.2-L, subject to the following:

1. If more than one efficiency standard is listed for any equipment in Tables 110.2-A through 110.2-L, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in Tables 110.2-A through 110.2-L, the equipment shall comply with the applicable efficiency standard when tested with each listed test method; and
3. Where equipment serves more than one function, it shall comply with the efficiency standards applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

Exception 1 to Section 110.2(a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ANSI/AHRI Standard 550/590 test conditions of 44°F leaving chilled water temperature and 85°F entering condenser water temperature with 3 gallons per minute per ton condenser water flow shall have a maximum full load kW/ton and NPLV ratings adjusted using the following equation:

Adjusted maximum full-load kW/ton rating = (full- load kW/ton from Table 110.2-D)/K_{adj}

Adjusted maximum NPLV rating = (IPLV from Table 110.2-D)/K_{adj}

Where:

K_{adj} = (A) × (B)

A = 0.00000014592 × (LIFT)^4 – 0.0000346496 × (LIFT)^3 + 0.00314196 × (LIFT)^2 – 0.147199 × (LIFT) + 3.9302

LIFT = L_{vg}Cond – L_{vg}Evap (°F)

L_{vg}Cond = Full-load leaving condenser fluid temperature (°F)

L_{vg}Evap = Full-load leaving evaporator fluid temperature (°F)

B = (0.0015 × L_{vg}Evap) + 0.934

The adjusted full-load and NPLV values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum Leaving Evaporator Fluid Temperature: 36°F
- Maximum Leaving Condenser Fluid Temperature: 115°F
- LIFT ≥ 20°F and ≤ 80°F

Centrifugal chillers designed to operate outside of these ranges are not covered by this exception.

Exception 2 to Section 110.2(a): Positive displacement (air-cooled and water-cooled) chillers with a leaving evaporator fluid temperature higher than 32°F shall show compliance with Table 110.2-D when tested or certified with water at standard rating conditions, per the referenced test procedure.

Exception 3 to Section 110.2(a): Equipment primarily serving refrigerated warehouses or commercial refrigeration.

> (b) **Controls for heat pumps with supplementary heaters.**

Control requirements for heat pumps with supplementary heaters in single-family residential buildings are specified in Section 150.0(h)7 and Section 150.0(i)2. Heat pumps with supplementary heaters in nonresidential and multifamily buildings shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for heat pump heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for heat pump heating is higher than the cut-off temperature for supplementary heating.

Exception 1 to Section 110.2(b): The controls may allow supplementary heater operation during:

A. Defrost; and

B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

Exception 2 to Section 110.2(b): Room air-conditioner heat pumps.

(c) **Thermostats.** All heating or cooling systems not controlled by a central energy management control system (EMCS) shall have a setback thermostat.

1. **Setback capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to program the temperature setpoints for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 110.2(b).

Exception to Section 110.2(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners and room air-conditioner heat pumps.

(d) **Gas-fired and oil-fired furnace standby loss controls.** Gas-fired and oil-fired forced-air furnaces with input ratings ≥ 225,000 Btu/hr shall also have an intermittent ignition or interrupted device (IID), and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings ≥ 225,000 Btu/hr, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

(e) **Open and closed-circuit cooling towers.** All open and closed-circuit cooling tower installations shall comply with the following:

1. Be equipped with conductivity controls that maximize cycles of concentration based on local water quality conditions. Controls shall automate system bleed and chemical feed based on conductivity. Conductivity controllers shall be installed in accordance with manufacturer's specifications in order to maximize accuracy.
2. Documentation of maximum achievable cycles of concentration. Building owners shall document the cycles of concentration achievable based on local water supply conditions as reported annually by the local water supplier, and using the calculations below. The calculations are intended to determine maximum achievable cycles of concentration based on the parameters identified in Table 110.2-A-1. Building owner shall document maximum achievable cycles of concentration on the mechanical compliance form which shall be reviewed and signed by the Professional Engineer (P.E.) of Record.

   The maximum achievable cycles of concentrations are based on the local water supply quality as reported by the local water supplier, and shall be the minimum of:

   A. 2,970 divided by the conductivity of the entering make-up water.
   B. 1,845 divided by the total dissolved solids of the entering make-up water.
   C. 540 divided by the M-alkalinity excluding galvanized steel of the entering make-up water.
   D. 450 divided by the M-alkalinity including galvanized steel of the entering make-up water.
   E. 540 divided by the calcium hardness of the entering make-up water.
   F. 270 divided by the chlorides of the entering make-up water.
   G. 225 divided by the sulfates of the entering make-up water.
   H. 135 divided by the silica of the entering make-up water.
   I. Langelier Saturation Index = $10\left(\frac{-1}{2.038895} * [Log(M * 0.9 * 1.219) - 0.061105 * Log(C * 0.8) + 0.55 * Log(H * M) + 0.0050325 * T - 5.95]\right)$

      where:

      C = Conductivity of the entering make-up water.

      H = Calcium hardness of the entering make-up water.

      M = M-alkalinity excluding galvanized steel of the entering make-up water.

      T = Max skin temperature.
3. Cooling towers shall not allow blowdown until one or more of the parameters in Table 110.2-A-1 reaches the maximum value specified:

TABLE 110.2-A-1 RECIRCULATING WATER PROPERTIES

RECIRCULATING WATER PARAMETERS	MAXIMUM VALUES
Conductivity (micro-siemens/cm)	2,970 micro-siemens/cm
Total dissolved solids (ppm)	1,845 ppm
Total alkalinity as CaCO3 (ppm) excluding galvanized steel	540 ppm
Total alkalinity as CaCO3 (ppm) galvanized steel (passivated)	450 ppm
Calcium hardness as CACO3 (ppm)	540 ppm
Chlorides as Cl (ppm)	270 ppm
Sulfates (ppm)	225 ppm
Silica (ppm)	135 ppm
Langelier saturation index (LSI)	2.5 (LSI)

4. Be equipped with a flow meter with an analog output for flow either hardwired or available through a gateway on the makeup water line.

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5. Be equipped with an overflow alarm to prevent overflow of the sump in case of makeup water valve failure. Overflow alarm shall send an audible signal or provide an alert via the energy management control system to the tower operator in case of sump overflow.
6. Be equipped with efficient drift eliminators that achieve drift reduction to 0.002 percent of the circulated water volume for counter-flow towers and 0.005 percent for cross-flow towers.
7. Conductivity controls and overflow alarm shall be verified according to NA 7.5.18.

Exception to Section 110.2(e): Open and closed-circuit cooling towers with rated capacity < 150 tons.

(f) **Low leakage air-handling units.** To qualify as a low leakage air-handling unit for use for meeting the requirements for applicable low leakage air-handling unit compliance credit(s) available in the performance standards set forth in Sections 150.1(b) and 140.1, the manufacturer shall certify to the Energy Commission that the air-handling unit meets the specifications in Reference Joint Appendix JA9.

TABLE 110.2-A—AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	EFFICIENCY[a]	TEST PROCEDURE[b]
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	11.2 EER[a] Federal Minimum IEER[a]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	11.0 EER[a] Federal Minimum IEER[a]	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	10.0 EER[a] Federal Minimum IEER[a]	
	≥ 760,000 Btu/h	9.7 EER[a] 12.5 IEER[a]	
Air conditioners, water cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Federal Minimum EER[a] 13.9 IEER[a]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Federal Minimum EER[a] 13.9 IEER[a]	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	Federal Minimum EER[a] 13.6 IEER[a]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	12.2 EER[a] 13.5 IEER[a]	ANSI/AHRI 340/360
Air conditioners, evaporatively cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Federal Minimum EER[a] 12.3 IEER[a]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Federal Minimum EER[a] 12.2 IEER[a]	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	Federal Minimum EER[a] 12.1 IEER[a]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	11.7 EER[a] 11.9 IEER[a]	ANSI/AHRI 340/360
Condensing units, air cooled	≥ 135,000 Btu/h	10.5 EER Federal Minimum IEER	ANSI/AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h	13.5 EER Federal Minimum IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	13.5 EER Federal Minimum IEER	

a. Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.
b. Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-B—HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY[a]	TEST PROCEDURE[b]
Air cooled (cooling mode), both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h		11.0 EER Federal Minimum IEER	AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.6 EER Federal Minimum IEER	
	≥ 240,000 Btu/h		9.5 EER Federal Minimum IEER	
Water source (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	86°F entering water	Federal Minimum EER	ISO-13256-1
Groundwater source (cooling mode)	< 135,000 Btu/h	59°F entering water	18.0 EER	ISO-13256-1

TABLE 110.2-B—HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS—continued

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY[a]	TEST PROCEDURE[b]
Ground source (cooling mode)	< 135,000 Btu/h	77°F entering water	14.1 EER	ISO-13256-1
Water source water-to-water (cooling mode)	< 135,000 Btu/h	86°F entering water	10.6 EER	ISO-13256-2
Groundwater source water-to-water (cooling mode)	< 135,000 Btu/h	59°F entering water	16.3 EER	ISO-13256-2
Ground source brine-to-water (cooling mode)	< 135,000 Btu/h	77°F entering water	12.1 EER	ISO-13256-2
Air cooled (heating mode) Split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	Federal Minimum COP	AHRI 340/360
		17°F db/15°F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	Federal Minimum COP	
	≥ 240,000 Btu/h and < 760,000 Btu/h		Federal Minimum COP	
	≥ 135,000 Btu/h (cooling capacity)	17°F db/15°F wb outdoor air	2.05 COP	
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	Federal Minimum COP	ISO-13256-1
	≥ 135,000 Btu/h and < 240,000 Btu/h	68°F entering water	Federal Minimum COP	ISO-13256-1
Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.7 COP	ISO-13256-1
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	3.2 COP	ISO-13256-1
Water source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	3.7 COP	ISO-13256-2
Groundwater source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.1 COP	ISO-13256-2
Ground source brine-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	2.5 COP	ISO-13256-2

a. Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.
b. Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-C—AIR-COOLED GAS-ENGINE HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY	TEST PROCEDURE[a]
Air-cooled gas-engine heat pump (cooling mode)	All capacities	95°F db outdoor air	0.60 COP	ANSI Z21.40.4A
Air-cooled gas-engine heat pump (heating mode)	All capacities	47°F db/43°F wb outdoor air	0.72 COP	ANSI Z21.40.4A

a. Applicable test procedure and reference year are provided under the definitions.

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TABLE 110.2-D—WATER CHILLING PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS[a, b]

EQUIPMENT TYPE	SIZE CATEGORY	PATH A EFFICIENCY[a, b]	PATH B EFFICIENCY[a, b]	TEST PROCEDURE[c]
Air cooled, with condenser electrically operated	< 150 tons	≥ 10.100 EER ≥ 13.700 IPLV	≥ 9.700 EER ≥ 15.800 IPLV	AHRI 550/590
	≥ 150 tons	≥ 10.100 EER ≥ 14.000 IPLV	≥ 9.700 EER ≥ 16.100 IPLV	
Air cooled, without condenser electrically operated	All capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		AHRI 550/590
Water cooled, electrically operated reciprocating	All capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590
Water cooled, electrically operated, positive displacement	< 75 tons	≤ 0.750 kW/ton ≤ 0.600 IPLV	≤ 0.780 kW/ton ≤ 0.500 IPLV	AHRI 550/590
	≥ 75 tons and < 150 tons	≤ 0.720 kW/ton ≤ 0.560 IPLV	≤ 0.750 kW/ton ≤ 0.490 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.660 kW/ton ≤ 0.540 IPLV	≤ 0.680 kW/ton ≤ 0.440 IPLV	
	≥ 300 tons and < 300 tons	≤ 0.610 kW/ton ≤ 0.520 IPLV	≤ 0.625 kW/ton ≤ 0.410 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Water cooled, electrically operated, centrifugal	> 150 ton	≤ 0.610 kW/ton ≤ 0.550 IPLV	≤ 0.695 kW/ton ≤ 0.440 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.610 kW/ton ≤ 0.550 IPLV	≤ 0.635 kW/ton ≤ 0.400 IPLV	
	≥ 300 tons and < 400 tons	≤ 0.560 kW/ton ≤ 0.520 IPLV	≤ 0.595 kW/ton ≤ 0.390 IPLV	
	≥ 400 tons and < 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Air cooled absorption single effect	All capacities	≥ 0.600 COP	N.A.[d]	AHRI 560
Water cooled absorption single effect	All capacities	≥ 0.700 COP	N.A.[d]	
Absorption double effect, indirect-fired	All capacities	≥ 1.000 COP ≥ 1.050 IPLV	N.A.[d]	
Absorption double effect, direct-fired	All capacities	≥ 1.000 COP ≥ 1.000 IPLV	N.A.[d]	
Water cooled gas engine driven chiller	All capacities	≥ 1.2 COP ≥ 2.0 IPLV	N.A.[d]	ANSI Z21.40.4

a. No requirements for:
- Centrifugal chillers with design leaving evaporator temperature < 36°F; or
- Positive displacement chillers with design leaving fluid temperature ≤ 32°F; or
- Absorption chillers with design leaving fluid temperature < 40°F.

b. Must meet the minimum requirements of Path A or Path B. However, both the full load (COP) and IPLV must be met to fulfill the requirements of the applicable path.

c. See Section 100.1 for definitions.

d. N.A. means not applicable.

>

TABLE 110.2-E—PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b, c, d]	TEST PROCEDURE[e]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥ 42.1 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥ 20.0 gpm/hp	
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	≥ 16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	≥ 7.0 gpm/hp	
Propeller or axial fan evaporative condensers	All	R-448A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb	≥ 157,000 Btu/h • hp	CTI ATC-106
	All	Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb	≥ 134,000 Btu/h • hp	
Centrifugal fan evaporative condensers	All	R-448A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb	≥ 135,000 Btu/h • hp	
	All	Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb	≥ 110,000 Btu/h • hp	
Air cooled condensers	All	125°F condensing temperature 190°F entering gas temperature 15°F subcooling 95°F entering dry-bulb	≥ 176,000 Btu/h·hp	AHRI 460
Propeller or axial fan dry coolers (air-cooled fluid coolers)	All	115°F entering water 105°F leaving water 95°F entering air db	≥ 4.5 gpm/hp	CTI ATC-105DS

a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated conditions divided by the fan motor nameplate power.

b. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the given rated conditions divided by the sum of the fan motor nameplate rated power and the integral spray pump motor nameplate power.

c. For purposes of this table, dry cooler performance is defined as the process water flow rating of the unit at the given thermal rating condition divided by the total fan motor nameplate power of the unit and air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power of the unit.

d. Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory-assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory-assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field-erected cooling towers.

e. Applicable test procedure and reference year are provided under the definitions. For refrigerated warehouses or commercial refrigeration applications, condensers shall comply with requirements specified by Section 120.6(a) or Section 120.6(b).

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TABLE 110.2-F —ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW (VRF) AIR CONDITIONERS MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF Air conditioners, Air cooled	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER Before 1/1/2023 Federal Minimum SEER2 On or After 1/1/2023	AHRI 1230 Before 1/1/2023 AHRI 210/240 On or After 1/1/2023
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER Federal Minimum IEER[b]	AHRI 1230
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER Federal Minimum IEER[b]	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	9.5 EER Federal Minimum IEER[b]	

a. Applicable test procedure and reference year are provided under the definitions.
b. IEERs are only applicable to equipment with capacity control as specified in ANSI/AHRI 1230 test procedures.

TABLE 110.2-G —ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW AIR-TO-AIR AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a, b]
VRF Air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER Before 1/1/2023 Federal Minimum SEER2 On or After 1/1/2023	AHRI 1230 Before 1/1/2023 AHRI 210/240 On or After 1/1/2023
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system[a]	10.3 EER Federal Minimum IEER[c]	AHRI 1230
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system[a]	9.9 EER Federal Minimum IEER[c]	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system[a]	9.1 EER Federal Minimum IEER[c]	
VRF Water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system[a] 86°F entering water	12.0 EER Federal Minimum IEER[c]	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system[a] 86°F entering water	12.0 EER Federal Minimum IEER[c]	
	≥ 135,000 Btu/h and < 240,000 Btu/h	All	VRF multisplit system[a] 86°F entering water	10.0 EER Federal Minimum IEER[c]	
	≥ 240,000 Btu/h	All	VRF multisplit system[a] 86°F entering water	10.0 EER Federal Minimum IEER	
VRF Groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system[a] 59°F entering water	16.2 EER	AHRI 1230
	≥ 135,000 Btu/h	All	VRF multisplit system[a] 59°F entering water	13.8 EER	
VRF Ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system[a] 77°F entering water	13.4 EER	AHRI 1230
	≥ 135,000 Btu/h	All	VRF multisplit system[a] 77°F entering water	11.0 EER	
VRF Air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)	—	VRF multisplit system	7.7 HSPF Before 1/1/2025 7.5 HSPF2 On or after 1/1/2025	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb outdoor air	Federal Minimum COP	
		—	VRF multisplit system 17°F db/15°F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb outdoor air	Federal Minimum COP	
		—	VRF multisplit system 17°F db/15°F wb outdoor air	2.05 COP	

TABLE 110.2-G —ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW AIR-TO-AIR AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS—continued

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a, b]
VRF Water source (heating mode)	< 65,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	Federal Minimum COP	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	Federal Minimum COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	Federal Minimum COP	
	≥ 240,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	Federal Minimum COP	
VRF Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.6 COP	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.3 COP	
VRF Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering water	3.1 COP	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering water	2.8 COP	

a. Deduct 0.2 from the required EERs and IEERs for variable refrigerant flow (VRF) multisplit system units with a heating recovery section.
b. Applicable test procedure and reference year are provided under the definitions.
c. IEERs are only applicable to equipment with capacity control as specified in ANSI/AHRI 1230 test procedures.

TABLE 110.2-H—DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	ENERGY RECOVERY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	Without energy recovery	NA	3.8 ISMRE2	AHRI 920
Air source heat pumps (dehumidification mode)	Without energy recovery	NA	3.8 ISMRE2	AHRI 920
Water cooled (dehumidification mode)	Without energy recovery	Cooling tower condenser water	4.7 ISMRE2	AHRI 920
Water source heat pump (dehumidification mode)	Without energy recovery	Ground source, closed and open loop	4.6 ISMRE2	AHRI 920
	Without energy recovery	Water source	3.8 ISMRE2	AHRI 920
Air source heat pumps (heating mode)	Without energy recovery	NA	2.05 ISCOP2	AHRI 920
Water source heat pump (heating mode)	Without energy recovery	Ground source, closed and open loop	2.13 ISCOP2	AHRI 920
	Without energy recovery	Water source	2.13 ISCOP2	AHRI 920
Air cooled (dehumidification mode)	With energy recovery	NA	5 ISMRE2	AHRI 920
Air source heat pumps (dehumidification mode)	With energy recovery	NA	5 ISMRE2	AHRI 920
Water cooled (dehumidification mode)	With energy recovery	Cooling tower condenser water	5.1 ISMRE2	AHRI 920
Water source heat pump (dehumidification mode)	With energy recovery	Ground source, closed and open loop	5.0 ISMRE2	AHRI 920
	With energy recovery	Water source	4.6 ISMRE2	AHRI 920
Air source heat pumps (heating mode)	With energy recovery	NA	3.2 ISCOP2	AHRI 920
Water source heat pump (heating mode)	With energy recovery	Ground source, closed and open loop	3.5 ISCOP2	AHRI 920
	With energy recovery	Water source	4.04 ISCOP2	AHRI 920

a. Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-I—HEAT PUMP AND HEAT RECOVERY CHILLER PACKAGES, COOLING OPERATION– MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY REFRIGERATING CAPACITY[a], TON_R	COOLING OPERATION EFFICIENCY[b, c, d, e], AIR SOURCE EER (FL/IPLV), Btu/Wh, LIQUID SOURCE POWER INPUT PER CAPACITY (FL/IPLV), kW/TON_R PATH A	COOLING OPERATION EFFICIENCY[b, c, d, e], AIR SOURCE EER (FL/IPLV), Btu/Wh, LIQUID SOURCE POWER INPUT PER CAPACITY (FL/IPLV), kW/TON_R PATH B	TEST PROCEDURE
Air source	< 150	> 5.595 FL |> 13.02 IPLV.IP	> 9.215 FL > 15.01 IPLV.IP	AHRI/550/590
Air source	> 150	> 5.595 FL > 13.30 IPLV.IP	> 9.215 FL > 15.30 IPLV.IP	AHRI/550/590
Liquid source electrically operated positive displacement	> 11.25[f] and < 150	< 0.7895 FL < 0.6316 IPLV.IP	< 0.8211 FL < 0.5263 IPLV.IP	AHRI/550/590
Liquid source electrically operated positive displacement	> 150 and < 300	< 0.7579 FL < 0.5895 IPLV.IP	< 0.7895 FL < 0.5158 IPLV.IP	AHRI/550/590
Liquid source electrically operated positive displacement	> 300 and < 400	< 0.6947 FL < 0.5684 IPLV.IP	< 0.7158 FL < 0.4632 IPLV.IP	AHRI/550/590
Liquid source electrically operated positive displacement	> 400 and < 600	< 0.6421 FL < 0.5474 IPLV.IP	< 0.6579 FL < 0.4316 IPLV.IP	AHRI/550/590
Liquid source electrically operated positive displacement	> 600	< 0.5895 FL < 0.5263 IPLV.IP	< 0.6158 FL < 0.4000 IPLV.IP	AHRI/550/590
Liquid source electrically operated centrifugal	> 11.25[f] and < 150	< 0.6421 FL < 0.5789 IPLV.IP	< 0.7316 FL < 0.4632 IPLV.IP	AHRI/550/590
Liquid source electrically operated centrifugal	> 150 and < 300	< 0.6190 FL < 0.5748 IPLV.IP	< 0.6684 FL < 0.4211 IPLV.IP	AHRI/550/590
Liquid source electrically operated centrifugal	> 300 and < 400	< 0.5895 FL < 0.5526 IPLV.IP	< 0.6263 FL < 0.4105 IPLV.IP	AHRI/550/590
Liquid source electrically operated centrifugal	> 400 and < 600	< 0.5895 FL < 0.5263 IPLV.IP	< 0.6158 FL < 0.4000 IPLV.IP	AHRI/550/590
Liquid source electrically operated centrifugal	> 600	< 0.5895 FL < 0.5263 IPLV.IP	< 0.6158 FL < 0.4000 IPLV.IP	AHRI/550/590

a. The size category is the full-load net refrigeration cooling mode capacity, which is the capacity of the evaporator available for cooling of the thermal load external to the chilling package.
b. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 (I-P), Table 4, except for liquid cooled centrifugal chilling packages, which can adjust cooling efficiency for nonstandard rating conditions using the K_{adj} procedure in accordance with Section 110.2(a).
c. For cooling operation, compliance with both the FL and IPLV is required, but only compliance with Path A or Path B cooling efficiency is required.
d. For units that operate in both cooling and heating, compliance with both the cooling and heating efficiency is required.
e. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recover COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1 or Hot-Water 2. Compliance with the cooling-only performance is required as defined in Notes b and c.
f. Water-to-water heat pumps with a capacity less than 135,000 Btu/h are included in Table 110.2-B, Heat Pumps—Minimum Efficiency Requirements.

TABLE 110.2-J—HEAT PUMP AND HEAT RECOVERY CHILLER PACKAGES, HEAT PUMP, HEATING OPERATION—MINIMUM EFFICIENCY REQUIREMENTS

SIZE CATEGORY REFRIGERATING CAPACITY[a], TON_R	HEATING SOURCE CONDITIONS (LEAVING LIQUID) OR OAT (db/wb)[b],°F	HEAT PUMP HEATING-FULL LOAD HEATING EFFICIENCY (COP_H)[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, LOW, 95°F/105°F	HEAT PUMP HEATING FULL LOAD HEATING EFFICIENCY (COP_H)[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, MEDIUM, 105°F/120°F	HEAT PUMP HEATING-FULL LOAD HEATING EFFICIENCY (COP_H)[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, HIGH, 120°F/140°F	HEAT PUMP HEATING-FULL LOAD HEATING EFFICIENCY (COP_H)[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, BOOST, 120°F/140°F	TEST PROCEDURE
Equipment Type: Air source						
< 150	47 db 43 wb	> 3.29	> 2.77	> 2.31	NA[j]	AHRI 550/590
< 150	17 db 15 wb	> 2.029	> 1.775	> 1.483	NA[j]	AHRI 550/590
> 150	47 db 43 wb	> 3.29	> 2.77	> 2.31	NA[j]	AHRI 550/590
> 150	17 db 15 wb	> 2.029	> 1.775	> 1.483	NA[j]	AHRI 550/590
Equipment Type: Liquid source electrically operated positive displacement						
> 11.25[h] and < 150	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	> 3.55	AHRI 550/590
> 150 and < 300	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	> 3.55	AHRI 550/590
> 300 and < 400	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 300 and < 400	65[i]	NA[j]	NA[j]	NA[j]	> 3.55	AHRI 550/590
> 400 and < 600	44[i]	> 4.93	> 3.96	> 2.97	NA[j]	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	> 3.9	AHRI 550/590
> 600	44[i]	> 4.93	> 3.96	> 2.97	NA[g]	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	> 3.9	AHRI 550/590
Equipment Type: Liquid source electrically operated centrifugal						
> 11.25[h] and < 150	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	> 3.55	AHRI 550/590
> 150 and < 300	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	> 3.55	AHRI 550/590
> 300 and < 400	44[i]	> 4.64	> 3.68	> 2.68	NA[j]	AHRI 550/590
> 300 and < 400	65[i]	NA[g]	NA[g]	NA[g]	> 3.55	AHRI 550/590
> 400 and < 600	44[i]	> 4.93	> 3.96	> 2.97	NA[j]	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	> 3.9	AHRI 550/590
> 600	44[i]	> 4.93	> 3.96	> 2.97	NA[j]	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	> 3.9	AHRI 550/590

a. The size category is the full-load net refrigeration cooling mode capacity, which is the capacity of the evaporator available for cooling of the thermal load external to the chilling package.
b. For air source heat pumps, compliance with both the 47°F and 17°F heating source outdoor air temperature (OAT) rating efficiency is required for heating.
c. Heating full-load rating conditions are at standard rating conditions defined in AHRI 550/590 (I-P), Table 4, includes the impact of defrost for air source heating ratings.
d. For units that operate in both cooling and heating, compliance with both the cooling and heating efficiency is required.
e. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recover COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1 or Hot-Water 2. Compliance with the cooling-only performance is required as defined in Notes b and c of Table 110.2-I.
f. For applications where the chilling package is installed to operate only in heating, compliance only with the heating performance COP_H is required at only one of the heating AHRI 550/590 (I-P) standard rating conditions of Low, Medium, High, or Boost. Compliance with cooling performance is not required.
g. For heat pump chilling package applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is only required at one of the heating AHRI 550/590 (I-P) standard rating conditions of Low, Medium, High, or Boost. Compliance with the cooling performance is required as defined in Notes b and c of Table 110.2-I, except as noted in Note f.
h. Water-to-water heat pumps with a capacity less than 135,000 Btu/h are included in Table 110.2-B, Heat Pumps—Minimum Efficiency Requirements.
i. Source leaving liquid temperature.
    1. The cooling evaporator liquid flow rate used for the heating rating for a reverse cycle air-to-water heat pump shall be the flow rate determined during the full load cooling rating.
    2. The cooling evaporator liquid flow rate for the simultaneous cooling and heating and heat recovery liquid cooled chilling packages rating shall be the liquid flow rates from the cooling operation full-load rating.
    3. For heating-only fluid-to-fluid chiller packages, the evaporator flow rate obtained with an entering liquid temperature of 54°F and a leaving liquid temperature of 44°F shall be used.
j. NA means the requirements are not applicable.

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TABLE 110.2-K—HEAT PUMP AND HEAT RECOVERY CHILLER PACKAGES, SIMULTANEOUS COOLING AND HEATING, HEATING OPERATION—MINIMUM EFFICIENCY REQUIREMENTS

SIZE CATEGORY REFRIGERATING CAPACITY[a], TON_R	HEATING SOURCE CONDITIONS (LEAVING LIQUID) OR OAT (db/wb)[b],°F	SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY $(COP_{SHC})^{c,d,e,f,g}$, W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, LOW, 95°F/105°F	SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY $(COP_{H})^{c,d,e,f,g}$, W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, MEDIUM, 105°F/120°F	SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY $(COP_{SHC})^{c,d,e,f,g}$, W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, HIGH, 120°F/140°F	SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY $(COP_{SHC})^{c,d,e,f,g}$, W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, BOOST, 120°F/140°F	TEST PROCEDURE
Equipment Type: Air source						
< 150	47 db 43 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
< 150	17 db 15 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150	47 db 43 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150	17 db 15 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
Equipment Type: Liquid source electrically operated positive displacement						
> 11.25[h] and < 150	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 150 and < 300	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 300 and < 400	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 300 and < 400	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 400 and < 600	44[i]	> 8.9	> 6.98	> 5	NA[j]	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	> 6.85	AHRI 550/590
> 600	44[i]	> 8.9	> 6.98	> 5	NA[j]	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	> 6.85	AHRI 550/590
Equipment Type: Liquid source electrically operated centrifugal						
> 11.25[h] and < 150	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 150 and < 300	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 300 and < 400	44[i]	> 8.33	> 6.41	> 4.42	NA[j]	AHRI 550/590
> 300 and < 400	65[i]	NA[j]	NA[j]	NA[j]	> 6.150	AHRI 550/590
> 400 and < 600	44[i]	> 8.9	> 6.98	> 5	NA[j]	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	> 6.85	AHRI 550/590
> 600	44[i]	> 8.9	> 6.98	> 5	NA[j]	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	> 6.85	AHRI 550/590

a. The size category is the full-load net refrigeration cooling mode capacity, which is the capacity of the evaporator available for cooling of the thermal load external to the chilling package.
b. For air source heat pumps, compliance with both the 47°F and 17°F heating source outdoor air temperature (OAT) rating efficiency is required for heating.
c. Heating full-load rating conditions are at standard rating conditions defined in AHRI 550/590 (I-P), Table 4, which includes the impact of defrost for air source heating ratings.
d. For units that operate in both cooling and heating, compliance with both the cooling and heating efficiency is required.
e. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recover COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1 or Hot-Water 2. Compliance with the cooling-only performance is required as defined in Notes b and c of Table 110.2-I.
f. Heating full load rating conditions are at standard rating conditions defined in AHRI 550/590 (I-P), Table 4 which includes the impact of defrost for air source heating ratings.
g. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} is only required at one of the heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, High or Boost. Compliance with cooling performance is required as defined in Notes b and c of Table 110.2-I.
h. Water-to-water heat pumps with a capacity less than 135,000 Btu/h are included in Table 110.2-B, Heat Pumps—Minimum Efficiency Requirements.
i. Source leaving liquid temperature.
    1. The cooling evaporator liquid flow rate used for the heating rating for a reverse cycle air-to-water heat pump shall be the flow rate determined during the full-load cooling rating.
    2. The cooling evaporator liquid flow rate for the simultaneous cooling and heating and heat recovery liquid cooled chilling packages rating shall be the liquid flow rates from the cooling operation full-load rating.
    3. For heating-only fluid-to-fluid chiller packages, the evaporator flow rate obtained with an entering liquid temperature of 54°F and a leaving liquid temperature of 44°F shall be used.
j. NA means the requirements are not applicable.

TABLE 110.2-L—HEAT PUMP AND HEAT RECOVERY CHILLER PACKAGES, HEAT RECOVERY, HEATING OPERATION—MINIMUM EFFICIENCY REQUIREMENTS

SIZE CATEGORY REFRIGERATING CAPACITY[a], TON_R	HEATING SOURCE CONDITIONS (LEAVING LIQUID) OR OAT (db/wb)[b],°F	HEAT RECOVERY HEATING FULL-LOAD EFFICIENCY (COP_{SHC})[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, LOW, 95°F/105°F	HEAT RECOVERY HEATING FULL-LOAD EFFICIENCY (COP_{SHC})[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, MEDIUM, 105°F/120°F	HEAT RECOVERY HEATING FULL-LOAD EFFICIENCY (COP_{SHC})[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, HIGH, 120°F/140°F	HEAT RECOVERY HEATING FULL-LOAD EFFICIENCY (COP_{SHC})[c, d, e, f, g], W/W, ENTERING/LEAVING HEATING LIQUID TEMPERATURE, BOOST, 120°F/140°F	TEST PROCEDURE
Equipment Type: Air Source						
< 150	47 db 43 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
< 150	17 db 15 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150	47 db 43 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150	17 db 15 wb	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
Equipment Type: Liquid source electrically operated positive displacement						
> 11.25[h] and < 150	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150 and < 300	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 300 and < 400	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 300 and < 400	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 400 and < 600	44[i]	> 8.9	> 6.98	> 5.5	> 5	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 600	44[i]	> 8.9	> 6.98	> 5.5	> 5	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
Equipment Type: Liquid source electrically operated centrifugal						
> 11.25[h] and < 150	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 11.25[h] and < 150	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 150 and < 300	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 150 and < 300	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 300 and < 400	44[i]	> 8.33	> 6.41	> 4.862	> 4.42	AHRI 550/590
> 300 and < 400	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 400 and < 600	44[i]	> 8.9	> 6.98	> 5.5	> 5	AHRI 550/590
> 400 and < 600	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590
> 600	44[i]	> 8.9	> 6.98	> 5.5	> 5	AHRI 550/590
> 600	65[i]	NA[j]	NA[j]	NA[j]	NA[j]	AHRI 550/590

a. The size category is the full-load net refrigeration cooling mode capacity, which is the capacity of the evaporator available for cooling of the thermal load external to the chilling package.

b. For air source heat pumps, compliance with both the 47°F and 17°F heating source outdoor air temperature (OAT) rating efficiency is required for heating.

c. Heating full-load rating conditions are at standard rating conditions defined in AHRI 550/590 (I-P), Table 4, which includes the impact of defrost for air source heating ratings.

d. For units that operate in both cooling and heating, compliance with both the cooling and heating efficiency is required.

e. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recover COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1 or Hot-Water 2. Compliance with the cooling-only performance is required as defined in Notes b and c of Table 110.2-I.

f. For liquid source heat recovery chilling packages that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COP_{HR} applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 110.2-D, Water Chilling Packages—Minimum Efficiency Requirements.

g. For heat recovery heating chilling package applications where there is simultaneous cooling and heating, compliance with the heating performance heat recover COP_{HR} is only required at one of the four heating AHRI 550/590 (I-P) standard ratings conditions of Low, Medium, Hot-Water 1 or Hot-Water 2. Compliance with the cooling-only performance is required as defined in Notes b and c of Table 110.2-I.

h. Water-to-water heat pumps with a capacity less than 135,000 Btu/h are included in Table 110.2-B, Heat Pumps—Minimum Efficiency Requirements.

i. Source leaving liquid temperature.
   1. The cooling evaporator liquid flow rate used for the heating rating for a reverse cycle air-to-water heat pump shall be the flow rate determined during the full-load cooling rating.
   2. The cooling evaporator liquid flow rate for the simultaneous cooling and heating and heat recovery liquid cooled chilling packages rating shall be the liquid flow rates from the cooling operation full-load rating.
   3. For heating-only fluid-to-fluid chiller packages, the evaporator flow rate obtained with an entering liquid temperature of 54°F and a leaving liquid temperature of 44°F shall be used.

j. NA means the requirements are not applicable.

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SECTION 110.3—MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any service water- heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. **Temperature controls for service water-heating systems.** Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 3, Chapter 50 of the ASHRAE Handbook, HVAC Applications Volume or Table 613.1 of the *California Plumbing Code* for healthcare facilities.

   Exception to Section 110.3(a)1: Residential occupancies.

(b) **Efficiency.** Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 110.1, subject to the following:

1. If more than one standard is listed in the Appliance Efficiency Regulations, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in the Appliance Efficiency Regulations, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

(c) **Installation.** Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr, outlets that require higher than service water temperatures as listed in the ASHRAE Handbook, Applications Volume, shall have separate remote heaters, heat exchangers or boosters to supply the outlet with the higher temperature.

   Exception to Section 110.3(c)1: Systems covered by *California Plumbing Code* Section 613.0 shall instead follow the requirements of that section.
2. **Controls for hot water distribution systems.** Service hot water systems with circulating pumps or with electrical heat trace systems shall be capable of automatically turning off the system.

   Exception to Section 110.3(c)2: Systems serving healthcare facilities.
3. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:
   A. External insulation with an installed *R*-value of at least R-3.5; or
   B. Internal and external insulation with a combined *R*-value of at least R-16; or
   C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
4. **Water heating recirculation loops serving multiple dwelling units, high-rise residential, hotel/motel, and nonresidential occupancies.** A water heating recirculation loop is a type of hot water distribution system that reduces the time needed to deliver hot water to fixtures that are distant from the water heater, boiler or other water heating equipment. The recirculation loop is comprised of a supply portion, connected to branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. A water heating recirculation loop shall meet the following requirements:
   A. **Air release valve or vertical pump installation.** An automatic air release valve shall be installed on the recirculation loop piping on the inlet side of the recirculation pump and no more than 4 feet from the pump. This valve shall be mounted on top of a vertical riser at least 12 inches in length and shall be accessible for replacement and repair. Alternatively, the pump shall be installed on a vertical section of the return line.
   B. **Recirculation loop backflow prevention.** A check valve or similar device shall be located between the recirculation pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop.
   C. **Equipment for pump priming.** A hose bibb shall be installed between the pump and the water heating equipment. An isolation valve shall be installed between the hose bibb and the water heating equipment. This hose bibb is used for bleeding air out of the pump after pump replacement.
   D. **Pump isolation valves.** Isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in Item C.
   E. **Cold water supply and recirculation loop connection to hot water storage tank.** Storage water heaters and boilers shall be plumbed in accordance with the manufacturer's specifications The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.
   F. **Cold water supply backflow prevention.** A check valve shall be installed on the cold water supply line between the hot water system and the next closest tee on the cold water supply line. The system shall comply with the expansion tank requirements as described in the *California Plumbing Code* Section 608.3.

5. **Service water heaters in state buildings.** Any newly constructed building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy, per the statutory requirement of California *Public Resources Code* Section 25498.

   Exception to Section 110.3(c)5: Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

6. **Isolation valves.** Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) shall have isolation valves on both the cold water supply and the hot water pipe leaving the water heater, and hose bibbs or other fittings on each valve for flushing the water heater when the valves are closed.

7. **Air-source heat pump water heaters (HPWH).** HPWH shall meet the following requirements:

   A. **Backup heat.** Backup heat is required for systems where inlet air is unconditioned, unless the compressor cut-off temperature is below the Heating Winter Median of Extremes for the closest location listed in Table 2-3 from Reference Joint Appendix JA2. Backup heat may be internal or external to the HPWH.

   B. **Ventilation.** Consumer integrated HPWHs shall meet one of the ventilation requirements below. Minimum volume and opening size requirements shall be the sum of all HPWHs installed within the same space. Compressor capacity shall be determined using AHRI 540 Table 4 reference conditions for refrigeration with the "High" rating test point:

      i. Installed using a method provided by the manufacturer to meet or exceed the level of performance provided by the ventilation requirements of Section 110.3(c)7B2 through Section 110.3(c)B4.

      ii. For HPWH installation without ducts, the installation space shall have a volume not less than the greater of 100 cubic feet per kBtu per hour of compressor capacity, or the minimum volume provided by the manufacturer for this method; or

      iii. For HPWH installation without ducts, the installation space shall be vented to a communicating space via permanent openings, according to the following requirements:

         a. Communicating space shall meet the minimum volume of Ssection 110.3(c)7B2 above, minus the volume of the HPWH installation space; and

         b. Permanent openings shall consist of a single layer of fixed flat slat louvers or grilles, with a total minimum Net Free Area (NFA) the larger of 125 square inches plus 25 square inches per kBtu per hour of compressor capacity, or the minimum provided by the manufacturer for this method. The permanent openings shall be fully louvered doors or two openings of equal area, one in the upper half of the enclosure and one in the bottom half of the enclosure. The top of the upper opening must be 12 inches or less from the enclosure top and the bottom of the lower vent must be 12 inches or less from the enclosure bottom; or

      iv. For HPWH installations with ducts, the following requirements shall be met:

         a. The space joined to the installation space via ducts shall meet the minimum volume of Section 110.3(c)7B2 above, minus the volume of the HPWH installation space; and

         b. All duct connections and building penetrations shall be sealed; and

         c. Exhaust air ducts and all ducts which cross pressure boundaries shall be insulated to minimum of R-6; and

         d. Where only the HPWH inlet or outlet is ducted, installation space shall include permanent openings that consist of a single layer of fixed flat slat louvers or grilles in the bottom half of the room, and/or a door undercut. With a ducted inlet, the minimum NFA shall be equal to the cross-sectional area of the duct. With a ducted exhaust, the minimum NFA shall be the larger of 20 square inches or the minimum NFA provided by the manufacturer for this method; and

         e. Where the inlet and outlet ducts both terminate within the same pressure boundary, airflow from the termination points shall be diverted away from each other.

      Note: Ducting only the inlet or the exhaust across the pressure boundary could interfere with balanced ventilation systems. This should be considered when specifying HPWH location and ventilation method.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 110.4—MANDATORY REQUIREMENTS FOR POOL AND SPA SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any pool theater for a pool, spa, or a pool and spa combination shall be installed only if the manufacturer has certified that the system or equipment has all of the following:

1. **Efficiency.** Equipment subject to State or federal appliance efficiency standards shall comply with the applicable provisions of Section 110.1; and
2. **On-off switch.** A readily accessible on-off switch, mounted on the outside of the heater that allows shutting off the heater without adjusting the thermostat setting; and
3. **Instructions.** A permanent, easily readable and weatherproof plate or card that provides the energy efficiency rating and instruction for the energy efficient operation of the pool and/or spa heater; and

(b) **Installation.** Any pool and/or spa system or equipment shall meet the following requirements:

1. **Heating equipment.** Equipment installed to heat water for pools and/or spas shall be selected from equipment meeting the standards shown in Table 110.4-A.

TABLE 110.4-A—HEATING EQUIPMENT STANDARDS

HEATING ENERGY SOURCE	STANDARD
Electric Resistance	UL 1261
Gas-fired	ANSI Z21.56/CSA 4.7a
Heat Pump	AHRI 1160 and one of the following: CSA C22.2 No. 236, UL 1995, or UL/CSA 60335-2-40
Solar	ICC/APSP 902/SRCC 400 for solar pool heaters, ICC 901/SRCC 100 for solar collectors

2. **Piping.** At least 18 inches of horizontal or vertical pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment;
3. **Covers.** Outdoor pools and/or spa with electric or gas heating equipment shall be installed with a pool cover.
4. **Directional inlets and time switches for pools.** If the system or equipment is for a pool:
   i. The pool shall have directional inlets that adequately mix the pool water; and
   ii. A time switch or similar control mechanism shall be permanently installed as part of a pool water circulation control system that will allow all pumps to be set or programmed to run only during off-peak electric demand period, and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

(c) **Heating source sizing.** Heating systems or equipment for pools and/or spas shall meet one of the sizing requirements 1 through 5 below:

1. A solar pool heating system with a solar collector surface area that is equivalent to the following:
   A. For nonresidential and multifamily buildings, 65 percent or greater of the pool and/or spa surface area.
   B. For single-family buildings, 60 percent or greater of the pool and/or spa surface area.
2. A heat pump pool heater as the primary heating system that meets the sizing requirements of Reference Joint Appendix JA16.3. The supplementary heater can be of any energy source; or
3. A heating system that derives at least 60 percent of the annual heating energy from on-site renewable energy or on-site recovered energy.
4. A combination of a solar pool heating system and heat pump pool heater without any additional supplementary heater; or
5. A pool heating system determined by the Executive Director to use no more energy than the systems specified in Items 1, 2, 3, or 4 above.

Exception 1 to Section 110.4(c): Portable electric spas compliant with 20 CCR §1605.3(g)(7) of the Appliance Efficiency Regulations.

Exception 2 to Section 110.4(c): Alterations to existing pools and/or spas with existing heating systems or equipment.

Exception 3 to Section 110.4(c): A pool and/or spa that is heated solely by a solar pool heating system without any backup heater.

Exception 4 to Section 110.4(c): Heating systems that are used exclusively for permanent spa applications in existing buildings with gas availability.

Exception 5 to Section 110.4(c): Heating systems that are used exclusively for permanent spa applications where there is an inadequate Solar Access Roof Area (SARA) as specified in Section 150.1(c)14 for a solar pool heating system to be installed.

(d) **Controls for heat pump pool heaters with supplementary heating.** Heat pump pool heaters with supplementary heaters shall have controls that meet the following:

1. A supplementary heater shall not operate when the heating load can be met by the heat pump pool heater alone; and
2. The cut-on temperature for heat pump heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for heat pump heating is higher than the cut-off temperature for supplementary heating.

SECTION 110.5—NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, POOL AND SPA HEATERS, AND FIREPLACES: PILOT LIGHTS PROHIBITED

Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:

(a) Fan-type central furnaces.

(b) Household cooking appliances.

Exception to Section 110.5(b): Household cooking appliances without an electrical supply voltage connection and in which each pilot consumes less than 150 Btu/hr.

(c) Pool heaters.

(d) Spa heaters.

(e) Indoor and outdoor fireplaces.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 110.6—MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of fenestration products and exterior doors other than field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified, that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft^2 of window area, 0.3 cfm/ft^2 of door area for residential doors, 0.3 cfm/ft^2 of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft^2 for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft^2), incorporated herein by reference.

   NOTES TO SECTION 110.6(a)1:

   Pet doors must meet 0.3 cfm/ft^2 when tested according to ASTM E283 at 75 pascals (or 1.57 pounds per square foot).

   AAMA/WDMA/CSA 101/I.S.2/A440-2011 specification is equivalent to ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds per square foot) and satisfies the air leakage certification requirements of this section.

   Exception to Section 110.6(a)1: Field-fabricated fenestration and field-fabricated exterior doors.

2. ***U*-factor.** The fenestration product and exterior door's *U*-factor shall be rated in accordance with NFRC 100, or use the applicable default *U*-factor set forth in Table 110.6-A.

   Exception 1 to Section 110.6(a)2: If the fenestration product is a skylight in a building covered by the nonresidential standards with less than 200 square feet of skylight area, the default *U*-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

   Exception 2 to Section 110.6(a)2: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product in a building covered by the nonresidential standards, the default *U*-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

3. **Solar heat gain coefficient SHGC.** The fenestration product's SHGC shall be rated in accordance with NFRC 200, or use the applicable default SHGC set forth in Table 110.6-B.

   Exception 1 to Section 110.6(a)3: If the fenestration product is a skylight in a building covered by the nonresidential standards with less than 200 square feet of skylight area, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

   Exception 2 to Section 110.6(a)3: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product in a building covered by the nonresidential standards, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

4. **Visible transmittance (VT).** The fenestration product's VT shall be rated in accordance with NFRC 200 or ASTM E972. For tubular daylighting devices VT shall be rated using NFRC 203.

   Exception 1 to Section 110.6(a)4: If the fenestration product is a skylight in a building covered by the nonresidential standards with less than 200 square feet of skylight area, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

   Exception 2 to Section 110.6(a)4: If the fenestration product is an alteration consisting of any area; replacement of glass in a skylight product in a building covered by the nonresidential standards, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

5. **Labeling.** Fenestration products and exterior doors shall:
   A. Have a temporary label for manufactured fenestration products and exterior doors or a label certificate when the component modeling approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)1. The temporary label shall not be removed before inspection by the enforcement agency; and
   B. Have a permanent label or label certificate when the component modeling approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)2 if the product is rated using NFRC procedures.

6. **Fenestration acceptance requirements.** Before an occupancy permit is granted site-built fenestration products in other than single-family buildings shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified in the Reference Nonresidential Appendix NA7 to ensure that site-built fenestration meets Standards requirements, including a matching label certificate for product(s) installed and be readily accessible at the project location. A certificate of accep-

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tance certifying that the fenestration product meets the acceptance requirements shall be completed, signed and submitted to the enforcement agency.

Exception to Section 110.6(a): Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of field-fabricated fenestration and exterior doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using *U*-factors from Table 110.6-A and SHGC values from Table 110.6-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

Exception to Section 110.6(b): Unframed glass doors and fire doors need not be weatherstripped or caulked.

TABLE 110.6-A—DEFAULT FENESTRATION PRODUCT *U*-FACTORS

FRAME[1,2]	PRODUCT TYPE	SINGLE PANE[3,4] *U*-FACTOR	DOUBLE PANE[1,3,4] *U*-FACTOR	GLASS BLOCK[2,3] *U*-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	NA
	Glazed doors	1.25	0.77	NA
	Skylight	1.98	1.3	NA
Metal, thermal break	Operable	NA	0.66	NA
	Fixed	NA	0.55	NA
	Greenhouse/garden window	NA	1.12	NA
	Glazed doors	NA	0.59	NA
	Skylight	NA	1.11	NA
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Greenhouse/garden window	0.99	0.53	NA
	Glazed doors	1.94	1.06	NA
	Skylight	1.47	0.84	NA

1. For all dual-glazed fenestration products, adjust the listed *U*-factors as follows:
   a. Add 0.05 for products with dividers between panes if spacer is less than $^{7}/_{16}$ inch wide.
   b. Add 0.05 to any product with true divided lite (dividers through the panes).
2. Translucent or transparent panels shall use glass block values when not rated by NFRC 100.
3. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.
4. Windows with window film applied that is not rated by NFRC 100 shall use the default values from this table.

TABLE 110.6-B—DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)

FRAME TYPE	PRODUCT	GLAZING	FENESTRATION PRODUCT SHGC		
			Single Pane[2,3] SHGC	Double Pane[2,3] SHGC	Glass Block[1,2] SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	NA
	Fixed	Tinted	0.68	0.60	NA
Metal, thermal break	Operable	Clear	NA	0.63	NA
	Fixed	Clear	NA	0.69	NA
	Operable	Tinted	NA	0.53	NA
	Fixed	Tinted	NA	0.57	NA
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	NA
	Fixed	Tinted	0.63	0.55	NA

1. Translucent or transparent panels shall use glass block values when not rated by NFRC 200.
2. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.
3. Windows with window film applied that is not rated by NFRC 200 shall use the default values from this table.

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SECTION 110.7—MANDATORY REQUIREMENTS TO LIMIT AIR LEAKAGE

All joints, penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather-stripped or otherwise sealed to limit infiltration and exfiltration.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 110.8—MANDATORY REQUIREMENTS FOR INSULATION, ROOFING PRODUCTS AND RADIANT BARRIERS

(a) **Insulation certification by manufacturers.** All insulation shall be certified by Department of Consumer Affairs, Bureau of Household Goods and Services that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12 – 13, Article 3, "Standards for Insulating Material."

(b) **Installation of urea formaldehyde foam insulation.** Urea formaldehyde foam insulation may be applied or installed only if:

1. It is installed in exterior side walls; and
2. A 4-mil-thick plastic polyethylene vapor retarder or equivalent plastic sheathing vapor retarder is installed between the urea formaldehyde foam insulation and the interior space in all applications.

(c) **Flamespread rating of insulation.** All insulating material shall be installed in compliance with the flamespread rating and smoke density requirements of the CBC.

(d) **Installation of insulation in existing buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of Subsections 1, 2 and 3 below. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of Subsections 1, 2 and 3 below.

1. **Attics.** If insulation is installed in the existing attic of a low-rise residential building, the *R*-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall meet the requirements of Section 150.0(a) for single-family buildings and Section 180.2(a)1 for multifamily buildings three habitable stories or fewer.

   Exception to Section 110.8(d)1: Where the accessible space in the attic is not large enough to accommodate the required *R*-value, the entire accessible space shall be filled with insulation, provided such installation does not violate Section 1202.2 of Title 24, Part 2 or Section 806 of Title 24, Part 2.5.
2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an *R*-value of at least R-3.5, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 605.0 of the CMC.

(e) **Reserved.**

(f) **Reserved.**

(g) **Insulation requirements for heated slab floors.** Heated slab floors shall be insulated according to the requirements in Table 110.8-A.

1. Insulation materials in ground contact must:
   A. Comply with the certification requirements of Section 110.8(a); and
   B. Have a water absorption rate for the insulation material alone without facings that is no greater than 0.3 percent when tested in accordance with Test Method A – 24 Hour-Immersion of ASTM C272.
   C. Water vapor permeance no greater than 2.0 perm/ inch when tested in accordance with ASTM E96.
2. Insulation installation must:
   A. Be covered with a solid guard that protects against damage from ultraviolet radiation, moisture, landscaping operation, equipment maintenance and wind; and
   B. Include a rigid plate, which penetrates the slab and blocks the insulation from acting as a conduit for insects from the ground to the structure above the foundation.

TABLE 110.8-A—SLAB INSULATION REQUIREMENTS FOR HEATED SLAB-ON-GRADE

INSULATION LOCATION	INSULATION ORIENTATIO N	INSTALLATION REQUIREMENTS	CLIMATE ZONE	INSULATION *R*-VALUE
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16 inches or to the frost line, whichever is greater. Insulation may stop at the top of the footing where this is less than the required depth. For below grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or to the frost line, whichever is greater.	1–15	5
			16	10
Between heated slab and outside foundation wall	Vertical and horizontal	Vertical insulation from top of slab at inside edge of outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in plan view.	1–15	5
			16	10 vertical and 7 horizontal

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(h) **Wet insulation systems.** When insulation is installed on roofs above the roofing membrane or layer used to seal the roof from water penetration, the effective *R*-value of the insulation shall be as specified in Reference Joint Appendix JA4.

(i) **Roofing products solar reflectance and thermal emittance.**

1. In order to meet the requirements of Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1I or 150.2(b)2, a roofing product's thermal emittance and an aged solar reflectance shall be certified and labeled according to the requirements of Section 10-113.

   Exception 1 to Section 110.8(i)1: Roofing products that are not certified according to Section 10-113 shall assume the following default aged solar reflectance/thermal emittance values:

   A. For asphalt shingles: 0.08/0.75

   B. For all other roofing products: 0.10/0.75

2. If CRRC testing for an aged solar-reflectance is not available for roofing product, the aged values shall be derived from the CRRC initial values using the equation $\rho_{aged} = [0.2 + \beta[\rho_{initial} - 0.2]$, where $\rho_{initial}$ = the initial solar reflectance and soiling resistance β is listed by product type in Table 110.8-B.

TABLE 110.8-B—VALUES OF SOILING RESISTANCE β BY PRODUCT TYPE

PRODUCT TYPE	CRRC PRODUCT CATEGORY	β
Field-Applied coating	Field-Applied coating	0.65
Other	Not a field-applied coating	0.70

3. Solar Reflectance Index (SRI), calculated as specified by ASTM E1980-11(2019), may be used as an alternative to thermal emittance and an aged solar reflectance when complying with the requirements of Sections 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1I or 150.2(b)2. SRI calculations shall be based on approach I from Section 6.1.1 of ASTM E1980-11 (2019) using only Equations 1 and 3 and a moderate wind velocity of 2–6 meters per second. The SRI shall be calculated based on the aged solar reflectance value of the roofing products.

4. Liquid applied roof coatings applied to low-sloped roofs in the field as the top surface of a roof covering shall:

   A. Be applied across the entire roof surface to meet the dry mil thickness or coverage recommended by the coating manufacturer, taking into consideration the substrate on which the coating is applied; and

   B. Meet the minimum performance requirements listed in Table 110.8-C or the minimum performance requirements of ASTM C836, D3468, D6083 or D6694, whichever are appropriate to the coating material.

   Exception 1 to Section 110.8(i)4B: Aluminum- pigmented asphalt roof coatings shall meet the requirements of ASTM D2824 and be installed as specified by ASTM D3805.

   Exception 2 to Section 110.8(i)4B: Cement- based roof coatings shall contain a minimum of 20 percent cement and shall meet the requirements of ASTM C1583, ASTM D822 and ASTM D5870.

(j) **Radiant barrier.** A radiant barrier shall have an emittance of 0.05 or less, tested in accordance with ASTM C1371 or ASTM E408, and shall be certified to the Department of Consumer Affairs as required by Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.

TABLE 110.8-C—MINIMUM PERFORMANCE REQUIREMENTS FOR LIQUID APPLIED ROOF COATINGS

PHYSICAL PROPERTY	ASTM TEST PROCEDURE	REQUIREMENT
Initial percent elongation (break)	D2370	Minimum 200% @ 73°F (23°C)
Initial percent elongation (break) or initial flexibility	D2370 D522, Test B	Minimum 60% @ 0°F (-18°C) Minimum pass 1″ mandrel @ 0°F (-18°C)
Initial tensile strength (maximum stress)	D2370	Minimum 100 psi (1.38 MPa) @ 73°F (23°C)
Initial tensile strength (maximum stress) or initial flexibility	D2370 D522, Test B	Minimum 200 psi (2.76 MPa) @ 0°F (-18°C) Minimum pass 1″ mandrel @ 0°F (-18°C)
Final percent elongation (break) after accelerated weathering 1000 h	D2370	Minimum 100% @ 73°F (23°C)
Final percent elongation (break) after accelerated weathering 100 h or Flexibility after accelerated weathering 100 h	D2370 D522, Test B	Minimum 40% @ 0°F (-18°C) Minimum pass 1″ mandrel @ 0°F (-18°C)
Permeance	D1653	Maximum 50 perms
Accelerated weathering 1000 h	D4798	No cracking or checking[1]

1. Any cracking or checking visible to the eye fails the test procedure.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 110.9—MANDATORY REQUIREMENTS FOR LIGHTING CONTROLS

(a) **All lighting control devices and systems and all light sources** subject to the requirements of Section 110.9 shall meet the following requirements:

1. Shall be installed only if the lighting control or light source complies with all of the applicable requirements of Section 110.9.
2. Lighting controls may be individual devices or systems consisting of two or more components.

(b) **All lighting controls.** Lighting controls listed in Section 110.9(b) shall comply with the requirements listed below; and all components of the system considered together as installed shall meet all applicable requirements for the application for which they are installed as required in Sections 130.0 through 130.5, Sections 140.6 through 140.8, Section 141.0, and Section 150.0(k).

1. **Time-switch lighting controls.** All controls that provide time-switch functionality, including all automatic and astronomical time-switch controls, shall have program backup capabilities that prevent the loss of the device's schedule for at least 7 days, and the device's date and time for at least 72 hours if power is interrupted. In addition:
   A. **Time-switch controls** installed in nonresidential buildings shall:
      i. For each connected load, be capable of providing manual override to each connected load and of resuming normally scheduled operation after a manual override is initiated within 2 hours; and
      ii. Provide an automatic holiday shutoff feature that turns off all connected loads for at least 24 hours and then resumes normally scheduled operation.
   B. **Astronomical time-switch controls** shall:
      i. Have sunrise and sunset prediction accuracy within plus-or-minus 15 minutes and timekeeping accuracy within 5 minutes per year;
      ii. Be capable of displaying date, current time, sunrise time, sunset time, and switching times for each step during programming;
      iii. Be capable of automatically adjusting for daylight savings time; and
      iv. Have the ability to independently offset the on and off for each channel by at least 90 minutes before and after sunrise or sunset.
   C. **Multilevel time-switch controls** shall include at least two separately programmable steps per zone.
   D. **Time-switch controls installed outdoors** shall have setback functions that allow the lighting on each controlled channel to be switched or dimmed to lower levels. The set back functions shall be capable of being programmed by the user for at least one specific time of day.
2. **Daylight responsive controls.** Controls that provide daylight responsive controls functionality shall:
   A. Automatically return to its most recent time delay settings within 60 minutes of the last received input when left in calibration mode;
   B. Have a set point control that easily distinguishes settings to within 10 percent of full-scale adjustment;
   C. Provide a linear response within 5 percent accuracy over the range of illuminance measured by the light sensor; and
   D. Be capable of being calibrated in a manner that the person initiating the calibration is remote from the sensor during calibration to avoid influencing calibration accuracy, for example by having a light sensor that is physically separated from where the calibration adjustments are made.
3. **Dimmers.** Controls that provide dimming functionality shall:
   A. Be capable of reducing lighting power consumption by a minimum of 65 percent when at its lowest setting;
   B. Provide reduced flicker operation, meaning that directly controlled light sources shall be provided electrical power such that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz without causing premature lamp failure;
   C. Provide an off setting that produces a zero lumen output; and
   D. For wall box dimmers and associated switches designed for use in three way circuits, be capable of turning lights off, and on to the level set by the dimmer if the lights are off.
4. **Occupant sensing controls.** Occupant sensing controls include occupant sensors, motion sensors, and vacancy sensors, including those with a partial-ON or partial-OFF function. Occupant sensing controls shall:
   A. Be capable of automatically turning the controlled lights in the area either off or down no more than 20 minutes after the area has been vacated;
   B. For manual-on controls, have a grace period of no less than 15 seconds and no more than 30 seconds to turn on lighting automatically after the sensor has timed out; and
   C. Provide a visible status signal that indicates that the device is operating properly, or that it has failed or malfunctioned. The visible status signal may have an override that turns off the signal.

   Exception to Section 110.9(b)4: Occupant sensing control systems may consist of a combination of single or multilevel occupant, motion or vacancy sensor controls, provided that components installed to comply with manual-on requirements shall not be capable of conversion by occupants from manual-on to automatic-on functionality.
5. **Reserved.**

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6. **Sensors used to detect occupants.** Sensors that are used by occupant sensing controls to detect occupants shall meet all of the following requirements:
   A. Sensors shall not incorporate switches or mechanical devices that allow the sensor to be disabled without changing the settings of the control.
   B. Sensors that utilize ultrasonic radiation for detection of occupants shall:
      i. comply with 21 C.F.R. part 1002.12;
      ii. not emit audible sound; and
      iii. not emit ultrasound in excess of the decibel levels shown in Table 110.9-A measured no more than 5 feet from the source, on axis.

TABLE 110.9-A—ULTRASOUND MAXIMUM DECIBEL VALUES

MID-FREQUENCY OF SOUND PRESSURE THIRD-OCTAVE BAND (IN kHz)	MAXIMUM DB LEVEL WITHIN THIRD-OCTAVE BAND (IN dB REFERENCE 20 MICROPASCALS)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 52943, *Public Resources Code*.

   C. Sensors that utilize microwave radiation for detection of occupants shall:
      i. comply with 47 C.F.R. parts 2 and 15; and
      ii. not emit radiation in excess of 1 milliwatt per square centimeter measured at no more than 5 centimeters from the emission surface of the device.
7. **Indicator lights.** Indicator lights integral to lighting controls shall consume no more than 1 watt of power per indicator light.

(c) **Track lighting integral current limiter.** An integral current limiter for line-voltage track lighting shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall have the identical volt-ampere (VA) rating of the current limiter as installed and rated for compliance with Part 6 clearly marked as follows:
   A. So that it is visible for the enforcement agency's field inspection without opening coverplates, fixtures or panels; and
   B. Permanently marked on the circuit breaker; and
   C. On a factory-printed label that is permanently affixed to a nonremovable base-plate inside the wiring compartment.
2. Shall have a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring or bypassing the device; and
3. Each electrical panel from which track lighting integral current limiters are energized shall have a factory printed label permanently affixed and prominently located, stating the following: "NOTICE: Current limiting devices installed in track lighting integral current limiters connected to this panel shall only be replaced with the same or lower amperage. Adding track or replacement of existing current limiters with higher continuous ampere rating will void the track lighting integral current limiter certification, and will require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards."

(d) **Track lighting supplementary overcurrent protection panel.** A Track Lighting Supplementary Overcurrent Protection Panel shall be used only for line-voltage track lighting and shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall be listed as defined in Section 100.1; and
2. Shall have a permanently installed label that is prominently located stating the following: "NOTICE: This Panel for Track Lighting Energy Code Compliance Only." The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other overcurrent protective device shall be added to this panel. Adding to, or replacement of, existing overcurrent protective device(s) with higher continuous ampere rating will void the panel listing and require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards.

SECTION 110.10—MANDATORY REQUIREMENTS FOR SOLAR READINESS

(a) **Covered occupancies.**

1. **Single-family residences.** Single-family residences located in subdivisions with ten or more single-family residences and where the application for a tentative subdivision map for the residences has been deemed complete or approved by the enforcement agency, which do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(e)

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2. **Low-rise multifamily buildings.** Low-rise multifamily buildings that do not have a photovoltaic system installed shall comply with the requirements of Sections 110.10(b) through 110.10(d).
3. **Hotel/motel occupancies and high-rise multifamily buildings.** Hotel/motel occupancies and high-rise multifamily buildings with ten habitable stories or fewer, that do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(d).
4. **Nonresidential buildings.** Nonresidential buildings with three habitable stories or fewer, other than I-2 and I-2.1 buildings, that do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(d).

(b) **Solar zone.**

1. **Minimum solar zone area.** The solar zone shall have a minimum total area as described below. The solar zone shall comply with access, pathway, smoke ventilation and spacing requirements as specified in Title 24, Part 9 or other Parts of Title 24 or in any requirements adopted by a local jurisdiction. The solar zone total area shall be comprised of areas that have no dimension less than five feet and are no less than 80 square feet each for buildings with roof areas less than or equal to 10,000 square feet or no less than 160 square feet each for buildings with roof areas greater than 10,000 square feet.
   A. **Single-family residences.** The solar zone shall be located on the roof or overhang of the building and have a total area no less than 250 square feet.

      Exception 1 to Section 110.10(b)1A: Single-family residences with a permanently installed domestic solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.50.

      Exception 2 to Section 110.10(b)1A: Single-family residences with three habitable stories or more and with a total floor area less than or equal to 2000 square feet and having a solar zone total area no less than 150 square feet.

      Exception 3 to Section 110.10(b)1A: Single-family residences located in the Wildland-Urban Interface Fire Area as defined in Title 24, Part 2 and having a whole house fan and having a solar zone total area no less than 150 square feet.

      Exception 4 to Section 110.10(b)1A: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 90 degrees and 300 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

      Exception 5 to Section 110.10(b)1A: Single-family residences having a solar zone total area no less than 150 square feet and where all thermostats are demand responsive controls and comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.

      Exception 6 to Section 110.10(b)1A: Single-family residences meeting the following conditions:

      A. All thermostats are demand responsive controls that comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.
      B. Comply with one of the following measures:
         i. Install a dishwasher that meets or exceeds the ENERGY STAR® Program requirements with a refrigerator that meets or exceeds the ENERGY STAR Program requirements, a whole house fan driven by an electronically commutated motor, or an SAE J1772 Level 2 Electric Vehicle Supply Equipment (EVSE or EV charger) with a minimum of 40 amperes; or
         ii. Install a home automation system capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or
         iii. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or
         iv. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

   B. **Multifamily buildings, hotel/motel occupancies and nonresidential buildings.** The solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building or on covered parking installed with the building project, and shall have a total area no less than 15 percent of the total roof area of the building excluding any skylight area. The solar zone requirement is applicable to the entire building, including mixed occupancy.

      Exception 1 to Section 110.10(b)1B: High-rise multifamily buildings, hotel/motel occupancies, and nonresidential buildings with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than one watt per square foot of roof area.

Exception 2 to Section 110.10(b)1B: High-rise multifamily buildings, hotel/motel occupancies with a permanently installed domestic solar water-heating system complying with Section 150.1(c)8Biii.

Exception 3 to Section 110.10(b)1B: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 90 degrees and 300 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

Exception 4 to Section 110.10(b)1B: Low-rise and high-rise multifamily buildings with all thermostats in each dwelling unit are demand response controls that comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency. In addition, either A or B below:

A. In each dwelling unit, comply with one of the following measures:
   i. Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with either a refrigerator that meets or exceeds the ENERGY STAR Program requirements or a whole house fan driven by an electronically commutated motor; or
   ii. Install a home automation system that complies with Section 110.12(a) and is capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or
   iii. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or
   iv. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

B. Meet the Title 24, Part 11, Section A4.106.8.2 requirements for electric vehicle charging spaces.

Exception 5 to Section 110.10(b)1B: Buildings where the roof is designed and approved to be used for vehicular traffic or parking or for a heliport.

2. **Azimuth range.** All sections of the solar zone located on steep-sloped roofs shall have an azimuth range between 90 degrees and 300 degrees of true north.
3. **Shading.**
   A. No obstructions, including but not limited to, vents, chimneys, architectural features and roof mounted equipment, shall be located in the solar zone.
   B. Any obstruction, located on the roof or any other part of the building that projects above a solar zone shall be located at least twice the distance, measured in the horizontal plane, of the height difference between the highest point of the obstruction and the horizontal projection of the nearest point of the solar zone, measured in the vertical plane.

   Exception to Section 110.10(b)3: Any roof obstruction, located on the roof or any other part of the building, that is oriented north of all points on the solar zone.
4. **Structural design loads on construction documents.** For areas of the roof designated as solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

Note: Section 110.10(b)4 does not require the inclusion of any collateral loads for future solar energy systems.

(c) **Interconnection pathways.**

1. The construction documents shall indicate a location reserved for inverters and metering equipment and a pathway reserved for routing of conduit from the solar zone to the point of interconnection with the electrical service.
2. For single-family residences and central water-heating systems, the construction documents shall indicate a pathway for routing of plumbing from the solar zone to the water-heating system.

(d) **Documentation.** A copy of the construction documents or a comparable document indicating the information from Sections 110.10(b) through 110.10(c) shall be provided to the occupant.

(e) **Main electrical service panel.**

1. The main electrical service panel shall have a minimum busbar rating of 200 amps.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation. The reserved space shall be permanently marked as “For Future Solar Electric”.

Note: Authority: Sections 25213, 25218, 25218.5, 25402, 25402.1, and 25605, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, 25605, and 25943, *Public Resources Code.*

SECTION 110.11—MANDATORY REQUIREMENTS FOR ELECTRICAL POWER DISTRIBUTION SYSTEM

Certification by Manufacturers. Any electrical power distribution system equipment listed in this section may be installed only if the manufacture has certified to the Commission that the equipment complies with all the applicable requirements of this section.

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(a) **Low-voltage dry-type distribution transformer** shall be certified by the Manufacturer as required by the Title 20 Appliance Efficiency Regulations.

EXCEPTION to Section 110.11(a):

1. autotransformer;
2. drive (isolation) transformer;
3. grounding transformer;
4. machine-tool (control) transformer;
5. nonventilated transformer;
6. rectifier transformer;
7. regulating transformer;
8. sealed transformer;
9. special-impedance transformer;
10. testing transformer;
11. transformer with tap range of 20 percent or more;
12. uninterruptible power supply transformer; or
13. welding transformer.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 110.12—MANDATORY REQUIREMENTS FOR DEMAND MANAGEMENT

Buildings, other than healthcare facilities, that install or are required to install demand responsive controls shall comply with the applicable demand responsive control requirements of Sections 110.12(a) through 110.12(e).

(a) **Demand responsive controls.**

1. All demand responsive controls shall be either:
   A. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification; or a certified Baseline Profile OpenADR 3.0 Virtual End Node; or
   B. Certified to the Energy Commission as being capable of responding to a demand response signal from a certified OpenADR 2.0b or a certified Baseline Profile OpenADR 3.0 Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls.
2. All demand responsive controls shall be capable of communicating with the VEN using a wired or wireless bidirectional communication protocol.
3. Reserved.
4. When the demand response signal is disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control.
5. Demand responsive control thermostats shall comply with Reference Joint Appendix 5 (JA5), Technical Specifications for Occupant Controlled Smart Thermostats.

(b) **Demand Responsive Zonal HVAC Controls.** Nonresidential HVAC systems with DDC to the Zone level shall be programmed to allow centralized demand shed for noncritical zones as follows:

1. The controls shall have a capability to remotely increase the operating cooling temperature set points by 4 degrees or more in all noncritical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).
2. The controls shall have a capability to remotely decrease the operating heating temperature set points by 4 degrees or more in all noncritical zones on signal from a centralized contact or software point within an EMCS.
3. The controls shall have capabilities to remotely reset the temperatures in all noncritical zones to original operating levels on signal from a centralized contact or software point within an EMCS.
4. The controls shall be programmed to provide an adjustable rate of change for the temperature increase, decrease, and reset.
5. The controls shall have the following features:
   A. Disabled. Disabled by authorized facility operators; and
   B. Manual control. Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and
   C. Automatic Demand Shed Control. Upon receipt of a demand response signal, the space-conditioning systems shall conduct a centralized demand shed, as specified in Sections 110.12(b)1 and 110.12(b)2, for noncritical zones during the demand response period.

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(c) **Demand Responsive Lighting Controls.** Buildings with nonresidential lighting systems having a total installed lighting power of 4,000 watts or greater that are subject to the requirements of Section 130.1(b) or 160.5(b)4B shall install controls that are capable of automatically reducing lighting power in response to a demand response signal.

1. For compliance testing, the lighting controls shall demonstrate a 15-percent or greater reduction in lighting power as described in NA7.6.3. The controls may provide additional demand responsive functions or abilities.
2. For buildings where demand response controls are required, demand responsive controls shall control the general lighting in the spaces required to meet Section 130.1(b) or 160.5(b)4B.
3. General lighting shall be reduced in a manner consistent with the requirements of Section 130.1(b) or 160.5(b)4B.

Exception to Section 110.12(c): Spaces where a health or life safety statute, ordinance, or regulation does not permit the general lighting to be reduced are not required to install demand responsive controls and do not count toward the 4,000-watt threshold.

(d) **Demand Responsive Electronic Message Center Control.** Controls for electronic message centers greater than 15 kW shall be capable of reducing the lighting power by a minimum of 30 percent when receiving a demand response signal.

Exception to Section 110.12(d): Electronic message centers that are not permitted by a health or life safety statute, ordinance, or regulation to be reduced.

(e) **Demand Responsive Controlled Receptacles.** In spaces required to have controlled receptacles per Section 130.5(d) or 160.6(d) and where demand responsive lighting controls are installed, the controlled receptacles shall be capable of automatically turning off all connected loads in response to a demand response signal.

Exception to Section 110.12(e): Spaces where a health or life safety statute, ordinance or regulation does not permit the receptacles to be automatically controlled.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SUBCHAPTER

3

NONRESIDENTIAL, HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES—MANDATORY REQUIREMENTS

SECTION 120.0—GENERAL

Sections 120.1 through 120.10 establish requirements for the design and installation of building envelopes, ventilation, space-conditioning and service water-heating systems and equipment in nonresidential and hotel/motel buildings as well as covered processes that are within the scope of Section 100.0(a).

Note: The requirements of Sections 120.1 through 120.10 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 120.1 through 120.10 also apply to additions or alterations to existing buildings.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.1—REQUIREMENTS FOR VENTILATION AND INDOOR AIR QUALITY

(a) **General requirements.**

1. All occupiable spaces in hotel/motel buildings, and nonresidential buildings other than healthcare facilities shall comply with the applicable requirements of Section 120.1(a) through 120.1(g). Healthcare facilities shall be ventilated in accordance with Chapter 4 of the *California Mechanical Code.*
2. The required outdoor air-ventilation rate and the air-distribution system design shall be clearly identified on the plans in accordance with Section 10-103 of Title 24, Part 1.

(b) **Reserved.**

(c) **Nonresidential and hotel/motel buildings.** All occupiable spaces shall meet the requirements of Section 120.1(c)1 and shall also comply with either Section 120.1(c)2 or Section 120.1(c)3.

1. **Air filtration.**

A. Mechanical system types specified in Subsections i, ii and iii below shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through any system thermal conditioning components. Air filters shall conform to the requirements of Sections 120.1(c)1B, 120.1(c)1C and 120.1(c)1D.

i. Mechanical space-conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems and energy recovery ventilation systems that provide outside air to an occupiable space.

Exception to Section 120.1(c)1A: For heat recovery ventilators and energy recovery ventilators, the location of the filters required by Section 120.1(c)1A may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

B. Air filter efficiency. The filters shall have a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30–1.0 µm range, and equal to or greater than 85 percent in the 1.0–3.0 µm range when tested in accordance with AHRI Standard 680; and

C. Systems shall be equipped with air filters that meet either Subsection i or ii below.

i. Nominal 2-inch minimum depth filter(s); or

ii. Nominal 1-inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 120.1-A, based on a maximum face velocity of 150 feet per minute.

(Equation 120.1-A) $A_{face} = Q_{filter} / V_{face}$

Where:

A_{face} = air filter face area, the product of air filter nominal length × nominal width, ft^2

Q_{filter} = design airflow rate for the air filter, ft^3/min

V_{face} = air filter face velocity ≤ 150, ft/min

D. Filter racks or grilles shall use gaskets, sealing or other means to close gaps around inserted filters and prevent air from bypassing the filter.

Exception to Section 120.1(c)1: Evaporative coolers are not subject to the air filtration requirements of Section 120.1(c)1.

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2. **Natural ventilation.** Naturally ventilated spaces shall be designed in accordance with 120.1(c)2A through 120.1(c)2D.
   A. Floor area to be ventilated. Spaces or portions of spaces to be naturally ventilated shall be located within a distance based on the ceiling height, as specified in i, ii and iii. The ceiling height (*H*) to be used in i, ii or iii shall be the minimum ceiling height in the space, or for ceilings that are increasing in height as distance from the operable openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet from the operable opening. [ASHRAE 62.1:6.4.1.1]
      i. Single side opening. For spaces with operable opening on one side of the zone, the naturally ventilated area shall extend to a distance not greater than two times the height (H) of the ceiling from the openings. [ASHRAE 62.1:6.4.1.3]
      ii. Double side opening. For zones with openings on two opposite sides of the zone, the naturally ventilated area shall extend between the openings separated by a distance not greater than five times the height of the ceiling. [ASHRAE 62.1:6.4.1.4]
      iii. Corner opening. For zones with operable openings on two adjacent sides of a zone, the naturally ventilated area shall extend to a distance not greater than five times the height of the ceiling along a line drawn between the outside edges of the two openings that are the farthest apart. The remaining area of the zone that is not bounded by the walls that have the openings and the line drawn between openings shall comply with item i above as having openings on only one side of the zone. [ASHRAE 62.1:6.4.1.5]
      iv. Ceiling height. The ceiling height (*H*) to be used in Section 120.1(c)2Ai through 120.1(c)2Aiii shall be the minimum ceiling height in the space.

      Exception to Section 120.1(c)2Aiv: For ceilings that are increasing in height as distance from the opening is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet from the operable openings. [ASHRAE 62.1:6.4.1.1]
   B. Location and size of openings. Zones or portions of zones to be naturally ventilated shall have a permanently open airflow path to openings directly connected to the outdoors. The openable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, the openable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet. [ASHRAE 62.1:6.4.1.6]
   C. Control and accessibility. The means to open the required operable opening shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]
   D. Naturally ventilated spaces shall also include a mechanical ventilation system designed in accordance with Section 120.1(c)3.

      Exception 1 to Section 120.1(c)2D: Spaces not served by a space-conditioning system.

      Exception 2 to Section 120.1(c)2D: Spaces where natural ventilation openings complying with Section 120.1(c)2 are either permanently open or have controls that prevent the openings from being closed during periods of expected occupancy.
3. **Mechanical ventilation.** Occupiable spaces shall be ventilated with a mechanical ventilation system capable of providing an outdoor airflow rate to the zone (V_z) no less than Equation 120.1-F as described below:

   (Equation 120.1-F) V_z = The larger of $R_p \times P_z$ or $R_a \times A_z$

   Where:

   R_p = 15 cubic feet per minute of outdoor airflow per person

   P_z = The expected number of occupants. For spaces without fixed seating, the expected number of occupants shall be the expected number specified by the building designer or the default occupancy density in Table 120.1-A times the occupiable floor area of the zone, whichever is greater. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with Section 1004.6 of the *California Building Code.*

   R_a = The area-based minimum ventilation airflow rate in Table 120.1-A.

   A_z = The net occupiable floor area of the ventilation zone in square feet.

   Exception 2 to Section 120.1(c)3: Transfer air. The rate of outdoor air required by Section 120.1(c)3 may be provided with air transferred from other ventilated space if:
   A. Use of transfer air is in accordance with Section 120.1(g); and
   B. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements of Section 120.1(c)3 for each space individually.
4. **Exhaust ventilation.** The design exhaust airflow shall be determined in accordance with the requirements in Table 120.1-B. Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air, or transfer air. [ASHRAE 62.1:6.5.1]

TABLE 120.1-A—MINIMUM VENTILATION RATES

OCCUPANCY CATEGORY	MINIMUM OCCUPANT LOAD DENSITY (persons/1,000 ft²)	AREA-BASED MINIMUM VENTILATION R_a (cfm/ft²)	AIR CLASS	NOTES
Educational Facilities				
Daycare (through age 4)	14	0.15	2	—
Daycare sickroom	5	0.15	3	—
Classrooms (ages 5–8)	25	0.15	1	—
Classrooms (age 9–18)	25	0.15	1	—
Lecture/postsecondary classroom	25	0.15	1	F
Lecture hall (fixed seats)	-71	0.15	1	F
Art classroom	25	0.15	2	—
Science laboratories	25	0.15	2	—
University/college laboratories	25	0.15	2	—
Wood/metal shop	10	0.15	2	—
Computer lab	25	0.15	1	—
Media center	25	0.15	1	A
Music/theater/dance	33	0.15	1	F
Multiuse assembly	33	0.15	1	F
Food and Beverage Service				
Restaurant dining rooms	33	0.15	2	—
Cafeteria/fast-food dining	33	0.15	2	—
Bars, cocktail lounges	33	0.20	2	—
Kitchen (cooking)	3	0.15	2	—
General				
Break rooms	33	0.15	1	F
Coffee Stations	33	0.15	1	F
Conference/meeting	33	0.15	1	F
Corridors	5	0.15	1	F
Occupiable storage rooms for liquids or gels	2	0.15	2	B
Hotels, Motels, Resorts, Dormitories				
Bedroom/living room	3	0.15	1	F
Barracks sleeping areas	5	0.15	1	F
Laundry rooms, central	5	0.15	2	—
Laundry rooms within dwelling units	5	0.15	1	—
Lobbies/pre-function	33	0.15	1	F
Multipurpose assembly	33	0.15	1	F
Office Buildings				
Breakrooms	33	0.15	1	
Main entry lobbies	33	0.15	1	F
Occupiable storage rooms for dry materials	2	0.15	1	
Office space	5	0.15	1	F
Reception areas	5	0.15	1	F
Telephone/data entry	33	0.15	1	F
Miscellaneous Spaces				
Bank vaults/safe deposit	5	0.15	2	F
Banks or bank lobbies	5	0.15	1	F
Computer (not printing)	5	0.15	1	F
Freezer and refrigerated spaces (< 50°F)	0	0	2	E
General manufacturing (excludes heavy industrial and process using chemicals)	5	0.15	3	—
Pharmacy (prep. Area)	5	0.15	2	—
Photo studios	5	0.15	1	—
Shipping/receiving	2	0.15	2	B
Sorting, packing, light assembly	2	0.15	2	—
Telephone closets	5	0.15	1	—
Transportation waiting	33	0.15	1	F
Warehouses	1	0.15	2	B
All others	5	0.15	2	—

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TABLE 120.1-A—MINIMUM VENTILATION RATES—continued

OCCUPANCY CATEGORY	MINIMUM OCCUPANT LOAD DENSITY (persons/1,000 ft^2)	AREA-BASED MINIMUM VENTILATION R_a (cfm/ft^2)	AIR CLASS	NOTES
Public Assembly Spaces				
Auditorium seating area	71	0.15	1	F
Places of religious worship	71	0.15	1	F
Courtrooms	13	0.15	1	F
Legislative chambers	13	0.15	1	F
Libraries (reading rooms and stack areas)	10	0.15	1	—
Lobbies	33	0.15	1	F
Museums (children's)	17	0.15	1	—
Museums/galleries	17	0.15	1	F
Residential				
Common corridors	5	0.15	1	—
Retail				
Sales (except as below)	17	0.20	2	—
Mall common areas	17	0.15	1	F
Barbershop	17	0.4	2	—
Beauty and nail salons	17	0.4	2	—
Pet shops (animal areas)	17	0.2	2	—
Supermarket	17	0.2	1	F
Coin-operated laundries	17	0.3	2	
Sports and Entertainment				
Gym, sports arena (play area)	10	0.15	2	E
Spectator areas	33	0.15	1	F
Swimming (pool)	10	0.15	2	C
Swimming (deck)	33	0.15	2	C
Disco/dance floors	100	0.15	2	F
Health club/aerobics room	10	0.15	2	—
Health club/weight rooms	10	0.15	2	—
Bowling alley (seating)	7	0.15	1	—
Gambling casinos	45	0.15	1	—
Game arcades	45	0.15	1	—
Stages, studios	33	0.15	1	D, F

General footnotes for Table 120.1-A:

1. The minimum occupant density is one-half of the maximum occupant load assumed for egress purposes in the CBC.

Specific Notes:

A – For high-school and college libraries, the values shown for "Public Assembly Spaces – Libraries" shall be used.

B – Rate may not be sufficient where stored materials include those having potentially harmful emissions.

C – Rate does not allow for humidity control. "Deck area" refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.

D – Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.

E – Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.

F – Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.

TABLE 120.1-B —MINIMUM EXHAUST RATES [ASHRAE 62.1: TABLE 6-2]

OCCUPANCY CATEGORY	EXHAUST RATE cfm/unit	EXHAUST RATE cfm/ft^2	AIR CLASS	NOTES
Animal imaging (MRI/CT/PET)	—	0.9	3	—
Animal operating rooms	—	3.00	3	—
Animal postoperative recovery room	—	1.5	3	—
Animal preparation rooms	—	1.5	3	—
Animal procedure room	—	2.25	3	—
Animal surgery scrub	—	1.50	3	—
Large-animal holding room	—	2.25	3	—
Animal necropsy	—	2.25	3	—
Small-animal-cage room (static cages)	—	2.25	3	—
Small-animal-cage room (ventilated cages)	—	1.50	3	—
Arenas	—	0.50	1	B
Art classrooms	—	0.70	2	—
Auto repair rooms	—	1.5	2	A
Barber shops	—	0.50	2	—
Beauty and nail salons	—	0.60	2	—
Cells with toilet	—	1.00	2	—
Copy, printing rooms	—	0.50	2	—
Darkrooms	—	1.00	2	—
Educational science laboratories	—	1.00	2	—
Janitor closets, trash rooms, recycling	—	1.00	3	—
Kitchenettes	—	0.30	2	—
Kitchens – commercial	—	0.70	2	—
Locker rooms for athletic or industrial facilities	—	0.50	2	—
All other locker rooms	—	0.25	2	—
Shower rooms	20/50	—	2	G,H
Paint spray booths	—	—	4	F
Parking garages	—	0.75	2	C
Pet shops (animal areas)	—	0.90	2	—
Refrigerating machinery rooms	—	—	3	F
Soiled laundry storage rooms	—	1.00	3	F
Storage rooms, chemical	—	1.50	4	F
Toilets – private	25/50	—	2	E
Toilets – public	50/70	—	2	D
Woodwork shop/classrooms	—	0.50	2	—

Notes:

A – Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.

B – Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.

C – Exhaust shall not be required where two or more sides comprise walls that are at least 50% open to the outside.

D – Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.

E – Rate is for a toilet room intended to be occupied by one person at a time. For continuous systems operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

F – See other applicable standards for exhaust rate.

G – For continuous system operation, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

H – Rate is per showerhead.

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TABLE 120.1-C—AIRSTREAMS OR SOURCES [ASHRAE 62.1:TABLE 6-3]	
DESCRIPTION	**AIR CLASS**
Commercial kitchen grease hoods	4
Commercial kitchen hoods other than grease	3
Diazo printing equipment discharge	4
Hydraulic elevator machine room	2
Laboratory hoods	4[a]
Paint spray booths	4
Refrigerating machinery rooms	3
a. Air Class 4 unless determined otherwise by the Environmental Health and Safety professional responsible to the owner or to the owner's designee.	

(d) **Operation and control requirements for minimum quantities of outdoor air.**

1. **Times of occupancy.** The minimum rate of outdoor air required by Section 120.1(c) shall be supplied to each space at all times when the space is usually occupied.

   Exception 1 to Section 120.1(d)1: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation), the rate of outdoor air may be reduced if the ventilation system serving the space is controlled by a demand control ventilation device complying with Section 120.1(d)4 or by an occupant sensor ventilation control device complying with Section 120.1(d)5.

   Exception 2 to Section 120.1(d)1: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 120.1(c) for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.

2. **Pre-occupancy.** The lesser of the minimum rate of outdoor air required by Section 120.1(c) or three complete air changes shall be supplied to the entire building during the one-hour period immediately before the building is normally occupied.

3. **Required demand control ventilation.** Demand ventilation controls complying with Section 120.1(d)4 are required for a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1,000 square feet (40 square feet or less per person) if the ventilation system serving the space has one or more of the following:

   A. An air economizer; or

   B. Modulating outside air control; or

   C. Design outdoor airflow rate > 3,000 cfm.

   Exception 1 to Section 120.1(d)3: Where space exhaust is greater than the design ventilation rate specified in Section 120.1(c)3 minus 0.2 cfm per square foot of conditioned area.

   Exception 2 to Section 120.1(d)3: Spaces that have processes or operations that generate dusts, fumes, mists, vapors or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, daycare sickrooms, science labs, barber shops or beauty and nail salons shall not install demand control ventilation.

   Exception 3 to Section 120.1(d)3: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people as specified by Section 120.1(c)3.

4. **Demand control ventilation devices.**

   A. For each system with demand control ventilation (DCV), CO_2 sensors shall be installed in each room that meets the criteria of Section 120.1(d)3 with no less than one sensor per 10,000 square feet of floor space. When a zone or a space is served by more than one sensor, a signal from any sensor indicating that CO_2 is near or at the setpoint within the zone or space, shall trigger an increase in ventilation.

   B. CO_2 sensors shall be located in the room between 3 feet and 6 feet above the floor or at the anticipated height of the occupants' heads.

   C. Demand ventilation controls shall maintain CO_2 concentrations less than or equal to 600 ppm plus the outdoor air CO_2 concentration in all rooms with CO_2 sensors.

      Exception to Section 120.1(d)4C: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 120.1(c)3 regardless of CO_2 concentration.

   D. Outdoor air CO_2 concentration shall be determined by one of the following:

      i. CO_2 concentration shall be assumed to be 400 ppm without any direct measurement; or

      ii. CO_2 concentration shall be dynamically measured using a CO_2 sensor located within 4 feet of the outdoor air intake.

E. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than $R_a \times A_z$ per Equation 120.1-F for each space with a CO_2 sensor(s), plus the greater of either the exhaust air rate or the rate required by Section 120.1(c)3 for other spaces served by the system.

F. CO_2 sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal which resets to supply the minimum quantity of outside air to levels required by Section 120.1(c)3 to the zone serviced by the sensor at all times that the zone is occupied.

G. The CO_2 sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with DDC to the zone level.

5. **Occupied-standby zone controls.**

A. Space conditioning zones shall include occupied standby controls complying with Section 120.1(d)5B when all of the following are true:

i. All rooms served by the zone are permitted to have their ventilation air reduced to zero while in occupied-standby mode per Table 120.1-A; and

ii. Occupant sensors are required by Sections 130.1(c)5 and 6; and

iii. The zone and ventilation system is not served by pneumatic controls.

B. Occupied-standby zone controls shall comply with the following:

i. Occupant sensors shall have suitable coverage and placement to detect occupants in the entire space. In 20 minutes or less after no occupancy is detected by any sensors covering the room, occupant sensing controls shall indicate a room is vacant.

ii. When occupant sensors controlling lighting are also used for ventilation, the ventilation signal shall be independent of daylighting, manual lighting overrides or manual control of lighting.

iii. When a single zone serves multiple spaces, there shall be an occupant sensor in each space and the zone shall not be considered vacant until all spaces in the zone are vacant.

iv. One hour prior to normal scheduled occupancy, the occupant sensor ventilation control shall allow pre-occupancy purge as described in Section 120.1(d)2.

v. When the zone is scheduled to be occupied and occupant sensing controls in all spaces served by the zone indicate the spaces are unoccupied, the zone shall be placed in occupied-standby mode.

vi. In 5 minutes or less after entering occupied-standby mode, mechanical ventilation to the zone shall be shut off until the space becomes occupied or until ventilation is needed to provide space heating or conditioning. When mechanical ventilation is shut off to the zone, the ventilation system serving the zone shall reduce the system outside air rate by the amount of outside air required for the zone.

vii. Where the system providing space conditioning also provides ventilation to the zone, in 5 minutes or less after entering occupied-standby mode, space-conditioning zone setpoints shall be reset in accordance with Section 120.2(e)3.

(e) **Ducting for zonal heating and cooling units.** Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit, which then supplies the air to a space in order to meet the requirements of Section 120.1(c)3, the outdoor air shall be ducted to discharge either:

1. Within 5 feet of the unit; or
2. Within 15 feet of the unit, substantially toward the unit, and at a velocity not less than 500 feet per minute.

(f) **Design and control requirements for quantities of outdoor air.**

1. All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers and controls that allow design minimum outside air rates to be operated at no less than the larger of (1) the minimum levels specified in Section 120.1(c)3; or (2) the rate required for make-up of exhaust systems that are required for a covered or non-covered process, for control of odors, or for the removal of contaminants within the space.
2. All variable air volume mechanical ventilation and space-conditioning systems shall include dynamic controls that are capable of maintaining measured outside air ventilation rates within 10 percent of the design minimum outside air ventilation rate at both full and reduced supply airflow conditions. Fixed minimum damper position is not considered to be dynamic and is not an allowed control strategy.
3. All mechanical ventilation and space-conditioning systems shall be tested to confirm their ability to operate within 10 percent of the design minimum outside air rate.

(g) **Air classification and recirculation limitations.** Air classification and recirculation limitations of air shall be based on the air classification as listed in Table 120.1-A or Table 120.1-C, and in accordance with the requirements of Sections 120.1(g)1 through 4.

Note: Air class definitions are taken directly from ASHRAE 62.1 and are duplicated here for convenience.

1. **Class 1 Air** is air with low contaminant concentration, low sensory-irritation intensity or inoffensive odor. Recirculation or transfer of Class 1 air to any space shall be permitted; [ASHRAE 62.1:5.13.3.1]

2. **Class 2 Air** is air with moderate contaminant concentration, mild sensory-irritation intensity or mildly offensive odors (Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes). Recirculation or transfer of Class 2 air shall be permitted in accordance with Sections 120.1(g)2A through 120.1(g)2E:
   A. Recirculation of Class 2 air within the space of origin shall be permitted [ASHRAE 62.1:5.13.3.2.1];
   B. Recirculation or transfer of Class 2 to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space [ASHRAE 62.1:5.13.3.2.2]; or
   C. Transfer of Class 2 air to toilet rooms [ASHRAE 62.1:5.13.3.2.3]; or
   D. Recirculation or transfer of Class 2 air to Class 4 spaces [ASHRAE 62.1:5.13.3.2.4]; or
   E. Class 2 air shall not be recirculated or transferred to Class 1 spaces. [ASHRAE 62.1:5.13.3.2.5]

   Exception to Section 120.1(g)2E: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 2 air shall not exceed 10 percent of the outdoor air intake flow.
3. **Class 3 Air** is air with significant contaminant concentration, significant sensory-irritation intensity or offensive odor. Recirculation or transfer of Class 3 air shall be permitted in accordance with Section 120.1(g)3A and B:
   A. Recirculation of Class 3 air within the space of origin shall be permitted. [ASHRAE 62.1:5.13.3.3.1]
   B. Class 3 air shall not be recirculated or transferred to any other space. [ASHRAE 62.1:5.13.3.3.2].

   Exception to Section 120.1(g)3B: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 3 air shall not exceed 5 percent of the outdoor air intake flow.
4. **Class 4 Air** is air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered as harmful. Class 4 air shall not be recirculated or transferred to any space or recirculated within the space of origin. [ASHRAE 62.1:5.13.3.4]
5. Ancillary spaces. Redesignation of Class 1 air to Class 2 air shall be permitted for Class 1 spaces that are ancillary to Class 2 spaces. [ASHRAE 62.1:5.13.2.3]
6. Transfer. A mixture of air that has been transferred through or returned from spaces or locations with different air classes shall be redesignated with the highest classification among the air classes mixed. [ASHRAE 62.1:5.13.2.2]
7. Classification. Air leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Tables 120.1-A, 120.1-B or 120.1-C. Air leaving spaces or locations that are not listed in Tables 120.1-A, 120.1-B or 120.1-C shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

(h) **Ventilation only mechanical systems.** HVAC systems without mechanical cooling or mechanical heating shall meet the requirements of Section 120.2(f).

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.2—REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 120.2(a) through 120.2(l).

(a) **Thermostatic controls for each zone.** The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 120.2(b). An energy management control system (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

Exception to Section 120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

1. All zones are also served by an interior cooling system; and
2. The perimeter system is designed solely to offset envelope heat losses or gains; and
3. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
4. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

(b) **Criteria for zonal thermostatic controls.** The individual thermostatic controls required by Section 120.2(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

Exception 1 to Section 120.2(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

Exception 2 to Section 120.2(b)3: Systems serving healthcare facilities.

4. Thermostatic controls for all single zone, air conditioners and heat pumps shall comply with the requirements of Sections 110.2(c) and 110.12(a) and, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 110.12(b).

Exception 1 to Section 120.2(b)4: Systems serving non-covered process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

Exception 2 to Section 120.2(b)4: Package terminal air conditioners, package terminal heat pumps, room air conditioners and room air conditioner heat pumps.

Exception 3 to Section 120.2(b)4: Systems serving healthcare facilities.

(c) **Hotel/motel guest room thermostats.**

1. Hotel/motel guest room thermostats shall:
   A. Have numeric temperature setpoints in °F and °C; and
   B. Have setpoint stops, which are accessible only to authorized personnel, such that guest room occupants cannot adjust the setpoint more than ±5°F (±3°C); and
   C. Meet the requirements of Section 110.2(c).

Exception to Section 120.2(c)1: Thermostats that are integrated into the room heating and cooling equipment.

(d) **Heat pump controls.** All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 110.2(b).

(e) **Shut-off and reset controls for space-conditioning systems.** Each space-conditioning system shall be installed with controls that comply with the following:

1. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:
   A. An automatic time switch control device complying with Section 110.9 with an accessible manual override that allows operation of the system for up to 4 hours; or
   B. An occupancy sensor; or
   C. A 4-hour timer that can be manually operated.

   Exception to Section 120.2(e)1: Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches and theaters equipped with 7-day programmable timers.
2. The control shall automatically restart and temporarily operate the system as required to maintain:
   A. A setback heating thermostat setpoint if the system provides mechanical heating; and

   Exception to Section 120.2(e)2A: Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 140.4(b)3 is greater than 32°F.
   B. A setup cooling thermostat setpoint if the system provides mechanical cooling.

   Exception to Section 120.2(e)2B: Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 140.4(b)3 is less than 100°F.
3. **Occupant sensing zone controls.** Where the system providing space conditioning also provides the ventilation required by Section 120.1 and includes occupant sensor ventilation control as specified in Section 120.1(d)5, the occupant sensing zone controls shall additionally comply with the following:
   A. In 5 minutes or less after entering occupied-standby mode as described in Section 120.1(d).
      i. Automatically set up the operating cooling temperature set point by 2°F or more and set back the operating heating temperature set point by 2°F or more; or
      ii. For multiple zone systems with Direct Digital Controls (DDC) to the zone level, setup the operating cooling temperature setpoint by 0.5°F or more and setback the operating heating temperature setpoint by 0.5°F or more.
   B. In 5 minutes or less after entering occupied-standby mode, mechanical ventilation to the zone shall remain off whenever the space temperature is between the active heating and cooling setpoints.

Exception 1 to Sections 120.2(e)1, 2, 3: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

Exception 2 to Sections 120.2(e)1, 2, 3: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

Exception 3 to Sections 120.2(e) 1 and 2: Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

4. Hotel and motel guest rooms shall have captive card key controls, occupancy sensing controls or automatic controls such that, no longer than 30 minutes after the guest room has been vacated, setpoints are set up at least +5°F (+3°C) in cooling mode and set down at least -5°F (-3°C) in heating mode.

Exception to Section 120.2(e): Systems serving healthcare facilities.

(f) **Dampers for air supply and exhaust equipment.** Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

Exception 1 to Section 120.2(f): Equipment that serves an area that must operate continuously.

Exception 2 to Section 120.2(f): Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

Exception 3 to Section 120.2(f): At combustion air intakes and shaft vents.

Exception 4 to Section 120.2(f): Where prohibited by other provisions of law.

(g) **Isolation area devices.** Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed and controlled to serve isolation areas.

1. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.
2. Each isolation area shall be provided with isolation devices, such as valves or dampers, that allow the supply of heating or cooling to be reduced or shut off independently of other isolation areas.
3. Each isolation area shall be controlled by a device meeting the requirements of Section 120.2(e)1.

Exception to Section 120.2(g): Zones designed to be conditioned continuously.

(h) **Automatic demand shed controls.** See Section 110.12 for requirements for automatic demand shed controls.

(i) **Economizer fault detection and diagnostics (FDD).** All newly installed air handlers with a mechanical cooling capacity over 33,000 Btu/hr and an installed air economizer shall include a stand-alone or integrated Fault Detection and Diagnostics (FDD) system in accordance with Subsections 120.2(i)1 through 120.2(i)8.

1. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air, and when required for differential economizer operation a return air sensor, and
2. Temperature sensors shall have an accuracy of ±2°F over the range of 40°F to 80°F; and
3. The controller shall have the capability of displaying the value of each sensor; and
4. The controller shall provide system status by indicating the following conditions:
   A. Free cooling available;
   B. Economizer enabled;
   C. Compressor enabled;
   D. Heating enabled, if the system is capable of heating; and
   E. Mixed-air low limit cycle active.
5. The unit controller shall allow manual initiation of each operating mode so that the operation of cooling systems, economizers, fans and heating system can be independently tested and verified; and
6. Faults shall be reported in one of the following ways:
   A. Reported to an Energy Management Control System regularly monitored by facility personnel.
   B. Annunciated locally on one or more zone thermostats, or a device within five (5) feet of zone thermostat(s), clearly visible, at eye level, and meeting the following requirements:
      i. On the thermostat, device, or an adjacent written sign, display instructions to contact appropriate building personnel or an HVAC technician; and
      ii. In buildings with multiple tenants, the annunciation shall either be within property management offices or in a common space accessible by the property or building manager.
   C. Reported to a fault management application which automatically provides notification of the fault to a remote HVAC service provider.
7. The FDD system shall detect the following faults:
   A. Air temperature sensor failure/fault;
   B. Not economizing when it should;
   C. Economizing when it should not;
   D. Damper not modulating; and
   E. Excess outdoor air.
8. The FDD System shall be certified to the Energy Commission as meeting requirements of Subsections 120.2(i)1 through 120.2(i)7 in accordance with Section 110.0 and JA6.3.

   Exception to Section 120.2(i)8: FDD algorithms based in direct digital control systems are not required to be certified to the Energy Commission.

(j) **Direct Digital Controls (DDC)**. Direct Digital Controls to the zone shall be provided as specified by Table 120.2-A. The provided DDC system shall meet the control logic requirements of Sections 120.1(d), 110.12(a) and 110.12(b), and be capable of the following:

The provided DDC system shall meet the control logic requirements of Sections 110.12(a), 110.12(b) and 120.1(d) and be capable of the following:

1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;
2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;
3. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;
4. Readily allow operator removal of zone(s) from the reset algorithm;
5. For new buildings, trending and graphically displaying input and output points; and
6. Resetting heating and cooling setpoints in all noncritical zones upon receipt of a signal from a centralized contact or software point as described in Section 110.12(b).

TABLE 120.2-A—DDC APPLICATIONS AND QUALIFICATIONS

BUILDING STATUS	APPLICATIONS	QUALIFICATIONS
Newly Constructed Buildings	Air handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV box	Where existing zones served by the same air handling, chilled water, or hot water systems that have DDC
	Air handling system or fan coil	Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
	New air handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new
	New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger
	New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger

(k) **Optimum start/stop controls.** Space conditioning systems with DDC to the zone level shall have optimum start/stop controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

Exception to Section 120.2(k): Systems that must operate continuously.

(l) **HVAC hot water temperature.** Zones that use hot water for space heating shall be designed for a hot water supply temperature of no greater than 130°F.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.3—REQUIREMENTS FOR PIPE INSULATION

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 120.3(a) through 120.3(c).

(a) **General requirements.** The piping conditions listed below for space-conditioning, service water-heating, and process heating and process cooling systems piping with fluid normal operating temperatures listed in Table 120.3-A-1 or Table 120.3-A2, and the fluid distribution system, shall have at least the amount of insulation specified in Subsection (c):

1. **Space cooling systems.** All refrigerant suction, chilled water, and brine fluid distribution systems.
2. **Space heating systems.** All refrigerant suction, steam, steam condensate and hot water fluid distribution systems.
3. **Service water-heating systems.**
   A. Recirculating system piping, including the supply and return piping to the water heater.
   B. The first 8 feet of hot and cold outlet piping, including piping between a storage tank and a heat trap, for a nonrecirculating storage system.

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C. Pipes that are externally heated.

4. **Process heating system piping.** All refrigerant, steam, steam condensate and hot water fluid distribution systems for heating a process unrelated to space conditioning or service water heating.
5. **Process cooling system piping.** All refrigerant suction, chilled water, and brine fluid distribution systems for cooling a process unrelated to space conditioning.

Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in Table 120.3-A1 or Table 120.3-A2, and shall be rounded to the nearest $^{1}/_{100}$ Btu-inch per hour per square foot per °F. Fluid distribution systems include all elements that are in series with the fluid flow, such as pipes, fittings, pumps, valves, strainers, coil u-bends, and air separators, but not including elements that are not in series with the fluid flow, such as expansion tanks, fill lines, chemical feeders, and drains.

Exception to Section 120.3(a)2: Heat pump refrigerant vapor line shall be installed with a minimum of 0.5-inch-thick or R-3.0 insulation for nonresidential buildings and 0.75-inch-thick or R-6.0 insulation for residential buildings. No insulation is required on the refrigerant liquid line.

(b) **Insulation protection.** Pipe insulation shall be protected from damage due to sunlight, moisture, equipment maintenance and wind. Protection shall, at minimum, include the following:

1. Pipe insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provides shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be used to provide this protection.
2. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.
3. Pipe insulation buried below grade must be installed in a water proof and noncrushable casing or sleeve.

(c) **Insulation thickness.**

1. For insulation with a conductivity in the range shown in Table 120.3-A-1 or Table 120.3-A-2 for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or *R*-value shown in Table 120.3-A1 or Table 120.3-A-2.
2. For insulation with a conductivity outside the range shown in Table 120.3-A-1 or Table 120.3-A-2 for the applicable fluid temperature range, the insulation shall have a minimum *R*-value shown in Table 120.3-A-1 or Table 120.3-A-2 or thickness as calculated:

MINIMUM INSULATION THICKNESS EQUATION

$$T = PR\left[\left(1 + \frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

where:

T = minimum insulation thickness for material with conductivity K, inches.

PR = pipe actual outside radius, inches.

t = insulation thickness from Table 120.3-A*1 or Table 120.3-A2*, inches.

K = conductivity of alternate material at the mean rating temperature indicated in Table 120.3-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 120.3-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

Exception 1 to Section 120.3: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

Exception 2 to Section 120.3: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

Exception 3 to Section 120.3: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

Exception 4 to Section 120.3: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing.

Exception 5 to Section 120.3: Fluid pumps, steam traps, blow-off valves, and piping within process equipment.

Exception 6 to Section 120.3: Valves, strainers, coil u-bends, air separators with at least 0.5 inches of insulation, and piping within process equipment.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

TABLE 120.3-A-1—SPACE HEATING AND SERVICE WATER HEATING SYSTEMS (STEAM, STEAM CONDENSATE, REFRIGERANT, SPACE HEATING, SERVICE HOT WATER) AND PROCESS HEATING SYSTEM PIPE INSULATION THICKNESS							
FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY (Btu·in/h·ft^2· °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER < 1 INCH	NOMINAL PIPE DIAMETER 1 TO < 1.5 INCHES	NOMINAL PIPE DIAMETER 1.5 TO < 4 INCHES	NOMINAL PIPE DIAMETER 4 TO < 8 INCHES	NOMINAL PIPE DIAMETER 8 INCHES AND LARGER
Above 350	*0.32–0.34*	*250*	*4.5 inches*	*5.0 inches*	*5.0 inches*	*5.0 inches*	*5.0 inches*
Above 350	*0.32–0.34*	*250*	*R-37*	*R-41*	*R-37*	*R -27*	*R-23*
251–350	*0.29–0.32*	*200*	*3.0 inches*	*4.0 inches*	*4.5 inches*	*4.5 inches*	*4.5 inches*
251–350	*0.29–0.32*	*200*	*R-24*	*R-34*	*R-35*	*R-26*	*R-22*
201–250	*0.27–0.30*	*150*	*2.5 inches*	*2.5 inches*	*2.5 inches*	*3.0 inches*	*3.0 inches*
201–250	*0.27–0.30*	*150*	*R -21*	*R-20*	*R-17.5*	*R-17*	*R-14.5*
141–200	*0.25–0.29*	*125*	*1.5 inches*	*1.5 inches*	*2.0 inches*	*2.0 inches*	*2.0 inches*
141–200	*0.25–0.29*	*125*	*R-11.5*	*R-11*	*R-14*	*R-11*	*R-10*
105–140	*0.22–0.28*	*100*	*1.0 inch*	*1.5 inches*	*1.5 inches*	*1.5 inches*	*1.5 inches*
105–140	*0.22–0.28*	*100*	*R 7.7*	*R 12.5*	*R-11*	*R-9*	*R-8*

Footnote to Table 120.3-A-1 and Table 120.3-A-2: These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

TABLE 120.3-A-2—SPACE COOLING SYSTEMS (CHILLED WATER, REFRIGERANT AND BRINE) AND PROCESS COOLING SYSTEM PIPE INSULATION THICKNESS							
FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY (Btu·in/h·ft^2· °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER < 1 INCH	NOMINAL PIPE DIAMETER 1 TO < 1.5 INCHES	NOMINAL PIPE DIAMETER 1.5 TO < 4 INCHES	NOMINAL PIPE DIAMETER 4 TO < 8 INCHES	NOMINAL PIPE DIAMETER 8 INCHES AND LARGER
Residential 40–60	*0.21–0.27*	*75*	*0.75 inch*	*0.75 inch*	*1.0 inch*	*1.0 inch*	*1.0 inch*
Residential 40–60	*0.21–0.27*	*75*	*R-6*	*R-5*	*R-7*	*R-6*	*R-5*
Nonresidential 40–60	*0.21–0.27*	*75*	*0.5 inch*	*0.5 inch*	*1.0 inch*	*1.0 inch*	*1.0 inch*
Nonresidential 40–60	*0.21–0.27*	*75*	*R-3*	*R-3*	*R-7*	*R-6*	*R-5*
Below 40	*0.20–0.26*	*50*	*1.0 inch*	*1.5 inches*	*1.5 inches*	*1.5 inches*	*1.5 inches*
Below 40	*0.20–0.26*	*50*	*R 8.5*	*R 14*	*R 12*	*R 10*	*R 9*

Footnote to Table 120.3-A-1 and Table 120.3-A-2: These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

SECTION 120.4—REQUIREMENTS FOR AIR DISTRIBUTION SYSTEM DUCTS AND PLENUMS

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 120.4(a) through 120.4(g).

Exception to Section 120.4: Systems serving healthcare facilities shall comply with the applicable requirements of the *California Mechanical Code.*

(a) **CMC compliance.** All air distribution system ducts and plenums, including but not limited to building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, and 605.0, and ANSI/SMACNA-006-2006 HVAC *Duct Construction Standards Metal and Flexible,* 3rd Edition incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.

Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

1. Outdoors; or
2. In a space between the roof and an insulated ceiling; or
3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or
4. In an unconditioned crawlspace; or
5. In other unconditioned spaces.

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Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 or be enclosed in directly conditioned space.

(b) **Duct and plenum materials.**

1. **Factory-fabricated duct systems.**
   - A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.
   - B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.
   - C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.
   - D. All ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

     Exception to Section 120.4(b)1D: Ductwork located in occupied space and exposed to view is not required to meet Seal Class A.

2. **Field-fabricated duct systems.**
   - A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.
   - B. **Mastic sealants and mesh.**
     - i. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 181B, and be nontoxic and water resistant.
     - ii. Sealants for interior applications shall pass ASTM C731 (extrudability after aging) and D2202 (slump test on vertical surfaces), incorporated herein by reference.
     - iii. Sealants for exterior applications shall pass ASTM tests C731, C732 (artificial weathering test), and D2202, incorporated herein by reference.
     - iv. Sealants and meshes shall be rated for exterior use.
   - C. **Pressure-sensitive tape.** Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.
   - D. All ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

     Exception to Section 120.4(b)2D: Ductwork located in occupied space and exposed to view is not required to meet Seal Class A.
   - E. **Drawbands used with flexible duct.**
     - i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.
     - ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
     - iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.
   - F. **Aerosol-sealant closures.**
     - i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.
     - ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

(c) All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor retarders or other duct components) and tested *C*-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

(d) The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

(e) Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor retarder or other duct components), based on the tests in Section 120.4(c) and the installed thickness determined by Section 120.4(d)3.

(f) **Protection of insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, but not limited to the following:

Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

(g) **Duct sealing.** Duct systems shall comply with Subsection 1 or 2 below:

1. New duct systems that meet the criteria in Subsections A, B, C and D below shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through acceptance testing, in accordance with Reference Nonresidential Appendix NA7.5.3;
   A. The duct system does not serve a healthcare facility; and
   B. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and
   C. The space-conditioning system serves less than 5,000 square feet of conditioned floor area; and
   D. The combined surface area of the ducts located outdoors or in unconditioned space is more than 25 percent of the total surface area of the entire duct system.
2. New duct systems that are not subject to testing under Section 120.4(g)1 shall instead meet the duct leakage testing requirements of CMC Section 603.9.2.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.5—REQUIRED NONRESIDENTIAL MECHANICAL SYSTEM ACCEPTANCE

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 120.5(a) through 120.5(b).

Exception to Section 120.5: Systems serving healthcare facilities.

(a) Before an occupancy permit is granted, the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

1. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1.
2. Constant volume, single zone unitary air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.
3. Duct systems that are subject to testing under Section 120.4(g)1, Section 141.0(b)2Di or Section 141.0(b)2Dii shall be tested in accordance with NA7.5.3.
4. Air economizers, DOAS, HRV or ERV systems shall be tested in accordance with NA7.5.4.

   Exception 1 to Section 120.5(a)4: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are not required to comply with the Functional Testing section of the air economizer controls acceptance test as described in NA7.5.4.2.

   Exception 2 to Section 120.5(a)4: The DOAS, HRV, or ERV unit that does not meet the exhaust air heat recovery ratio as specified in Section 140.4(q)1 or does not include bypass or control to disable energy recovery as specified in Section 140.4(q)2.
5. Demand control ventilation systems required by Section 120.1(c)3 shall be tested in accordance with NA7.5.5.
6. Supply fan variable flow controls shall be tested in accordance with NA7.5.6.
7. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9.
8. Boiler or chillers that require isolation controls as specified by Section 140.4(k)2 or 140.4(k)3 shall be tested in accordance with NA7.5.7.
9. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8.
10. Automatic demand shed controls shall be tested in accordance with NA7.5.10.
11. Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units shall be tested in accordance with NA7.5.11.
12. Automatic fault detection and diagnostics (FDD) for air handling units and zone terminal units shall be tested in accordance with NA7.5.12.
13. Distributed Energy Storage DX AC Systems shall be tested in accordance with NA7.5.13.
14. Thermal Energy Storage (TES) Systems shall be tested in accordance with NA7.5.14.
15. Supply air temperature reset controls shall be tested in accordance with NA7.5.15.
16. Water-cooled chillers served by cooling towers with condenser water reset controls shall be tested in accordance with NA7.5.16.
17. When an energy management control system is installed, it shall functionally meet all of the applicable requirements of Part 6.
18. Occupant sensing zone controls shall be tested in accordance with NA7.5.17.
19. Conductivity controls and overflow alarms for open and closed-circuit cooling towers shall be tested according to NA7.5.18.

(b) When certification is required by Title 24, Part 1, Section 10-103.2, the acceptance testing specified by Section 120.5(a) shall be performed by a certified mechanical acceptance test technician (CMATT). If the CMATT is operating as an employee, the CMATT shall

be employed by a certified mechanical acceptance test employer. The CMATT shall disclose on the certificate of acceptance a valid CMATT certification identification number issued by an approved acceptance test technician certification provider. The CMATT shall complete all certificate of acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

Note: Authority cited: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402(a)-(b), 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 120.6—MANDATORY REQUIREMENTS FOR COVERED PROCESSES

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 120.6(a) through 120.6(k), and the applicable requirements of Sections 110.2(a) and 120.3.

(a) **Mandatory requirements for refrigerated warehouses.**

Refrigerated warehouses that are greater than or equal to 3,000 square feet and refrigerated spaces with a sum total of 3,000 square feet or more that are served by the same refrigeration system shall meet the requirements of Section 120.6(a).

Refrigerated spaces that are less than 3,000 square feet shall meet the requirements of the Appliance Efficiency Regulations for walk-in coolers or freezers contained in the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through 1608).

1. **Insulation requirements.** Exterior surfaces of refrigerated warehouses shall be insulated at least to the *R*-values in Table 120.6-A-1.

TABLE 120.6-A-*1*—REFRIGERATED WAREHOUSE INSULATION

SPACE	SURFACE	MNIMUM *R*-VALUE (°F·hr·sf/Btu)
Freezers	Roof/ceiling	R-40
	Wall	R-36
	Floor	R-35
	Floor with all heating from productive refrigeration capacity[1]	R-20
Coolers	Roof/ceiling	R-28
	Wall	R-28

1. All underslab heating is provided by a heat exchanger that provides refrigerant subcooling or other means that result in productive refrigeration capacity on the associated refrigerated system.

2. **Underslab heating.** Electric resistance heat shall not be used for the purposes of underslab heating.

   Exception to Section 120.6(a)2: Underslab heating systems controlled such that the electric resistance heat is thermostatically controlled and disabled during the summer on-peak period defined by the local electric utility.

3. **Evaporators.** New fan-powered evaporators used in coolers and freezers shall conform to the following:

   A. Single phase fan motors less than 1 hp and less than 460 Volts in newly installed evaporators shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions.

   B. Evaporator fans served either by a suction group with multiple compressors or by a single compressor with variable capacity capability shall be variable speed and the speed shall be controlled in response to space temperature or humidity.

      Exception 1 to Section 120.6(a)3B: Addition, alteration or replacement of less than all of the evaporators in an existing refrigerated space that does not have speed-controlled evaporators.

      Exception 2 to Section 120.6(a)3B: Coolers within refrigerated warehouses that maintain a controlled atmosphere for which a licensed engineer has certified that the types of products stored will require constant operation at 100 percent of the design airflow.

      Exception 3 to Section 120.6(a)3B: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling/freezing of products, including but not limited to spaces with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 square feet).

   C. Evaporator fans served by a single compressor that does not have variable capacity shall utilize controls to reduce airflow by at least 40 percent for at least 75 percent of the time when the compressor is not running.

      Exception to Section 120.6(a)3C: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling/freezing of products [space with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 square feet)].

   D. Fan-powered evaporators utilizing volatile refrigerants shall meet the applicable efficiency requirements listed in Table 120.6-A-2.

      Evaporator specific efficiency is defined as the gross total refrigeration capacity (Btu/h) divided by the electrical input power at 100 percent fan speed at rating conditions listed in Table 120.6-A-2 following the test procedure listed in Table 120.6-A-2.

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Exception to Section 120.6(a)3D: Evaporators designed solely for the purpose of quick chilling/freezing of products, including but not limited to spaces with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2).

E. The applied static pressure drop for evaporators shall not exceed 0.5 in. water.

Exception to Section 120.6(a)3E: Evaporators designed solely for the purpose of quick chilling/freezing of products, including but not limited to spaces with design cooling capacities of greater that 240 Btu/hr-ft^2 (2 tons per 100 ft^2).

TABLE 120.6-A-2—FAN-POWERED EVAPORATORS—MINIMUM SPECIFIC EFFICIENCY REQUIREMENTS

EVAPORATOR TYPE[1, 2]	RATING CONDITION	EFFICIENCY (Btuh/watt)	TEST PROCEDURE[3]
Direct Expansion, Ammonia Refrigerant, Cooler/Dock	Dry Coil +25°F saturated evaporating temperature +35°F entering drybulb temperature 0 in. water static pressure	35	AHRI 420
Direct Expansion, Ammonia Refrigerant, Freezer	Dry Coil -20°F saturated evaporating temperature -10°F entering drybulb temperature 0 in. water static pressure	25	AHRI 420
Liquid Overfeed, Ammonia Refrigerant, Cooler/Dock	Dry Coil +25°F saturated evaporating temperature +35°F entering drybulb temperature 0 in. water static pressure	50	AHRI 420
Liquid Overfeed, Ammonia Refrigerant, Freezer	Dry Coil -20°F saturated evaporating temperature -10°F entering drybulb temperature 0 in. water static pressure	45	AHRI 420
Direct Expansion, CO_2 Refrigerant, Cooler/Dock	Dry Coil +25°F saturated evaporating temperature +35°F entering drybulb temperature 0 in. water staticpressure	35	AHRI 420
Direct Expansion, CO_2 Refrigerant, Freezer	Dry Coil -20°F saturated evaporating temperature -10°F entering drybulb temperature 0 in. water static pressure	25	AHRI 420
Liquid Overfeed, CO_2 Refrigerant, Cooler/Dock	Dry Coil +25°F saturated evaporating temperature +35°F entering drybulb temperature 0 in. water static pressure	50	AHRI 420
Liquid Overfeed, CO_2 Refrigerant, Freezer	Dry Coil -20°F saturated evaporating temperature -10°F entering drybulb temperature 0 in. water static pressure	45	AHRI 420
Direct Expansion, Halocarbon Refrigerant, Cooler/Dock	Dry Coil +25°F saturated evaporating dew point temperature +35°F entering drybulb temperature 0 in. water static pressure	45	AHRI 1250
Direct Expansion, Halocarbon Refrigerant, Freezer	Dry Coil -20°F saturated evaporating dew point temperature -10°F entering drybulb temperature 0 in. water static pressure	40	AHRI 1250

1. Direct expansion: Evaporator in which leaving refrigerant vapor is superheated.
2. Liquid overfeed: Evaporator in which refrigerant liquid is supplied at a recirculation rate greater than 1.
3. Applicable test procedure and reference year are provided under the definitions.

4. **Condensers.** New fan-powered condensers on new refrigeration systems shall conform to the following:
   A. Design saturated condensing temperatures for evaporative-cooled condensers and water-cooled condensers served by fluid coolers or cooling towers shall be less than or equal to:
      i. The design wetbulb temperature plus 20°F in locations where the design wetbulb temperature is less than or equal to 76°F; or
      ii. The design wetbulb temperature plus 19°F in locations where the design wetbulb temperature is between 76°F and 78°F; or

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iii. The design wetbulb temperature plus 18°F in locations were the design wetbulb temperature is greater than or equal to 78°F.

Exception 1 to Section 120.6(a)4A: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2), or process refrigeration cooling for other than a refrigerated space.

Exception 2 to Section 120.6(a)4A: Condensing units that are components of walk-in coolers or walk-in freezers within the scope of the Appliance Efficiency Regulations.

B. Design saturated condensing temperatures for air-cooled condensers shall be less than or equal to:

i. The design drybulb temperature plus 10°F for systems serving freezers;

ii. The design drybulb temperature plus 15°F for systems serving coolers.

Exception 1 to Section 120.6(a)4B: Condensing units that are components of walk-in coolers or walk-in freezers within the scope of the Appliance Efficiency Regulations.

Exception 2 to Section 120.6(a)4B: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2), or process refrigeration cooling for other than a refrigerated space.

C. The saturated condensing temperature necessary for adiabatic condensers to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to:

i. The design drybulb temperature plus 20°F for systems serving freezers;

ii. The design drybulb temperature plus 30°F for systems serving coolers.

Exception 1 to Section 120.6(a)4C: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/freezing of products [space with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2)], or process refrigeration cooling for other than a refrigerated space.

Exception 2 to Section 120.6(a)4C: Condensing units that are components of walk-in coolers or walk-in freezers within the scope of the Appliance Efficiency Regulations.

D. All condenser fans for air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air or water fluid coolers or cooling towers shall be continuously variable speed, with system shall control the speed of all fans serving a common condenser high side controlled in unison.

E. The minimum condensing temperature setpoint shall be less than or equal to 70°F for systems utilizing air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air or water-cooled fluid coolers or cooling towers for heat rejection.

F. Condensing temperature reset. The condensing temperature set point of systems served by air-cooled condensers shall be reset in response to ambient drybulb temperature. The condensing temperature set point of systems served by evaporative-cooled condensers or water-cooled condensers (via cooling towers or fluid coolers) shall be reset in response to ambient wetbulb temperatures. The condensing temperature set point for systems served by adiabatic condensers shall be reset in response to ambient drybulb temperature while operating in dry mode.

Exception 1 to Section 120.6(a)4F: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide at least equal energy savings.

Exception 2 to Section 120.6(a)4F: Systems served by adiabatic condensers in Climate Zones 1, 3, 5, 12, 14 and 16.

G. Fan-powered condensers shall meet the condenser efficiency requirements listed in Table 120.6-B. Condenser efficiency is defined as the total heat of rejection (THR) capacity divided by all electrical input power including fan power at 100 percent fan speed, and power of spray pumps for evaporative condensers.

Exception 1 to Section 120.6(a)4G: Adiabatic condensers with ammonia as refrigerant.

Exception 2 to Section 120.6(a)4G: Condensing units that are components of walk-in coolers or walk-in freezers within the scope of the Appliance Efficiency Regulations.

H. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

Exception 1 to Section 120.6(a)4H: Micro-channel condensers.

Exception 2 to Section 120.6(a)4H: Condensing units that are components of walk-in coolers or walk-in freezers within the scope of the Appliance Efficiency Regulations.

Exception to Section 120.6(a)4: Transcritical CO_2 refrigeration systems.

TABLE 120.6-B—FAN-POWERED CONDENSERS – MINIMUM EFFICIENCY REQUIREMENTS			
CONDENSER TYPE	**REFRIGERANT TYPE**	**MINIMUM EFFICIENCY**	**RATING CONDITION**
Outdoor evaporative cooled with THR Capacity > 8,000 MBH	All	350 Btuh/Watt	100°F saturated condensing temperature (SCT), 70°F outdoor wetbulb temperature
Outdoor evaporative cooled with THR Capacity < 8,000 MBH and indoor evaporative cooled	All	160 Btuh/Watt	
Outdoor air cooled	Ammonia	75 Btuh/Watt	105°F saturated condensing temperature (SCT), 95°F outdoor drybulb temperature
	Halocarbon	65 Btuh/Watt	
Adiabatic dry mode	Halocarbon	45 Btuh/Watt	105°F saturated condensing temperature (SCT), 95°F outdoor drybulb temperature
Indoor air cooled	All	No requirement	

5. **Compressors.** Compressor systems utilized in refrigerated warehouses shall conform to the following:
   A. Compressors serving refrigeration systems that are not transcritical CO_2 shall be designed to operate at a minimum condensing temperature of 70°F or less.
   B. Compressors for transcritical CO_2 refrigeration systems shall be designed to operate at a minimum condensing temperature of 60°F or less.

      Exception to Section 120.6(a)5B: Compressors with a design saturated suction temperature greater than or equal to 30°F shall be designed to operate at a minimum condensing temperature of 70°F or less.
   C. New open-drive screw compressors in new refrigeration systems with a design saturated suction temperature (SST) of 28°F or lower that discharges to the system condenser pressure shall control compressor speed in response to the refrigeration load.

      Exception 1 to Section 120.6(a)5C: Refrigeration plants with more than one dedicated compressor per suction group.

      Exception 2 to Section 120.6(a)5C: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/ freezing of products [space with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2)], or process refrigeration cooling for other than a refrigerated space.
   D. New screw compressors with nominal electric motor power greater than 150 HP shall include the ability to automatically vary the compressor volume ratio (Vi) in response to operating pressures.
   6. **Infiltration barriers.** Passageways between freezers and higher-temperature spaces, and passageways between coolers and nonrefrigerated spaces, shall have an infiltration barrier consisting of strip curtains, an automatically-closing door or an air curtain designed by the manufacturer for use in the passageway and temperature for which it is applied.

      Exception 1 to Section 120.6(a)6: Openings with less than 16 square feet of opening area.

      Exception 2 to Section 120.6(a)6: Dock doorways for trailers.
7. **Refrigerated warehouse acceptance.** Before an occupancy permit is granted for a new refrigerated warehouse, or before a new refrigeration system serving a refrigerated warehouse is operated for normal use, the following equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the Reference Nonresidential Appendix NA7. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:
   A. Electric resistance underslab heating systems shall be tested in accordance with NA7.10.1.
   B. Evaporators fan motor controls shall be tested in accordance with NA7.10.2.
   C. Evaporative condensers shall be tested in accordance with NA7.10.3.1.
   D. Air-Cooled condensers shall be tested in accordance with NA7.10.3.2.
   E. Adiabatic condensers shall be tested in accordance with NA7.10.3.3.
   F. Variable speed compressors shall be tested in accordance with NA7.10.4.
   G. Transcritical CO_2 refrigeration systems shall be tested in accordance with NA7.20.1.
8. **Transcritical CO_2 gas coolers.** New fan-powered gas coolers on all new transcritical CO_2 refrigeration systems shall conform to the following:
   A. Air-cooled gas coolers are prohibited in Climate Zones 9 through 15.
   B. Design leaving gas temperature for air-cooled gas coolers shall be less than or equal to the design dry-bulb temperature plus 6°F.

      Exception to Section 120.6(a)8B: Design leaving gas temperature for air-cooled gas coolers in Climate Zones 2, 4 and 8 shall be less than or equal to the design dry-bulb temperature plus 8°F.

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C. Design leaving gas temperature for adiabatic gas coolers necessary to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to the design dry-bulb temperature plus 15°F.

D. All gas cooler fans shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

E. While operating below the critical point, the gas cooler pressure shall be controlled in accordance with Section 120.6(a)4F.

F. While operating above the critical point, the gas cooler pressure setpoint shall be reset based on ambient conditions such that the system efficiency is maximized.

G. The minimum condensing temperature setpoint shall be less than or equal to 60°F for systems utilizing air-cooled gas coolers, evaporative-cooled gas coolers, adiabatic gas coolers, air or water-cooled fluid coolers or cooling towers for heat rejection.

Exception to Section 120.6(a)8G: Transcritical CO_2 refrigeration systems with a design intermediate saturated suction temperature greater than or equal to 30°F shall have a minimum condensing temperature setpoint of 70°F or less.

H. Fan-powered gas coolers shall meet the gas cooler efficiency requirements listed in Table 120.6-C. Gas cooler efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power (fan power at 100 percent fan speed).

TABLE 120.6-C—TRANSCRITICAL CO_2 FAN-POWERED GAS COOLERS—MINIMUM EFFICIENCY REQUIREMENTS

CONDENSER TYPE	REFRIGERANT TYPE	MINIMUM EFFICIENCY	RATING CONDITION
Outdoor air cooled	Transcritical CO_2	160 Btuh/watt	1400 psig, 100°F outlet gas temperature, 90°F outdoor dry-bulb temperature
Adiabatic dry mode	Transcritical CO_2	90 Btuh/watt	1100 psig, 100°F outlet gas temperature, 90°F outdoor dry-bulb temperature

9. **Automatic door closers.** Doors designed for the passage of people that are between freezers and higher-temperature spaces, or between coolers and nonrefrigerated spaces, shall have automatic door closers.

(b) **Mandatory requirements for commercial refrigeration.**

Retail food or beverage stores with 8,000 square feet or more of conditioned floor area, and that utilize either refrigerated display cases, or walk-in coolers or freezers shall meet all applicable state and federal appliance and equipment standards consistent with Section 110.0 and 110.1 or, for equipment not subject to such standards, the requirements of Subsections 1 through 4.

1. **Condensers serving refrigeration systems.** Fan-powered condensers shall conform to the following requirements:

A. All condenser fans for air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air- or water-cooled fluid coolers or cooling towers shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

B. The refrigeration system condenser controls for systems with air-cooled condensers shall use variable- setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature.

C. The refrigeration system condenser controls for systems with evaporative-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient wetbulb temperature.

D. The refrigeration system condenser controls for systems with adiabatic condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature while operating in dry mode.

Exception 1 to Section 120.6(b)1B, C and D: Condensing temperature control strategies approved by the executive director that have been demonstrated to provide equal energy savings.

Exception 2 to Section 120.6(b)1D: Systems served by adiabatic condensers in Climate Zone 16.

E. The saturated condensing temperature necessary for adiabatic condensers to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to:

i. The design drybulb temperature plus 20°F for systems serving freezers;

ii. The design drybulb temperature plus 30°F for systems serving coolers.

F. The minimum condensing temperature setpoint shall be less than or equal to 70°F.

G. Fan-powered condensers shall meet the specific efficiency requirements listed in Table 120.6-D.

Exception 1 to Section 120.6(b)1G: Condensers with a total heat rejection capacity of less than 150,000 Btuh at the specific efficiency rating condition.

Exception 2 to Section 120.6(b)1G: Stores located in Climate Zone 1.

Exception 3 to Section 120.6(b)1G: Existing condensers that are reused for an addition or alteration.

TABLE 120.6-D—FAN-POWERED CONDENSERS—SPECIFIC EFFICIENCY REQUIREMENTS		
CONDENSER TYPE	**MINIMUM SPECIFIC EFFICIENCY[a]**	**RATING CONDITION**
Evaporative cooled	160 Btuh/Watt	100°F saturated condensing temperature (SCT), 70°F outdoor wetbulb temperature
Air cooled	160 Btuh/Watt	105°F saturated condensing temperature (SCT), 95°F outdoor drybulb temperature
Adiabatic dry mode	45 Btu/W (halocarbon)	105°F saturated condensing temperature (SCT), 95°F outdoor drybulb temperature
a. See Section 100.1 for definition of condenser specific efficiency.		

H. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

Exception 1 to Section 120.6(b)1H: Microchannel condensers.

Exception 2 to Section 120.6(b)1H: Existing condensers that are reused for an addition or alteration.

Exception to Section 120.6(b)1B, 1C, 1D, 1E, 1F, 1G: Transcritical CO_2 refrigeration systems.

Exception to Section 120.6(b)1: New condensers replacing existing condensers when the attached compressor system total heat of rejection does not increase and less than 25 percent of both the attached compressors and the attached display cases are new.

2. **Compressor systems.** Refrigeration compressor systems and condensing units shall conform to the following requirements:

A. Compressors and multiple-compressor suction groups shall include control systems that use floating suction pressure logic to reset the target saturated suction temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

Exception 1 to Section 120.6(b)2A: Single compressor systems that do not have continuously variable capacity capability.

Exception 2 to Section 120.6(b)2A: Suction groups that have a design saturated suction temperature of 30°F or higher, or suction groups that comprise the high stage of a two-stage or cascade system or that primarily serve chillers for secondary cooling fluids.

B. Liquid subcooling shall be provided for all low temperature compressor systems with a design cooling capacity equal or greater than 100,000 Btu/hr with a design saturated suction temperature of -10°F or lower, with the subcooled liquid temperature maintained continuously at 50°F or less at the exit of the subcooler, using compressor economizer port(s) or a separate medium or high temperature suction group operating at a saturated suction temperature of 18°F or higher.

Exception 1 to Section 120.6(b)2B: Low temperature cascade systems that condense into another refrigeration system rather than condensing to ambient temperature.

Exception 2 to Section 120.6(b)2B: Transcritical CO_2 refrigeration systems.

C. Compressors for transcritical CO_2 refrigeration systems shall be designed to operate at a minimum condensing temperature of 60°F or less.

Exception to Section 120.6(b)2C: Compressors with a design saturated suction temperature greater than or equal to 30°F shall be designed to operate at a minimum condensing temperature of 70°F or less.

Exception to Section 120.6(b)2: Existing compressor systems that are reused for an addition or alteration.

3. **Refrigerated display cases.** Lighting in refrigerated display cases, and lights on glass doors installed on walk-in coolers and freezers shall be controlled by one of the following:

A. Automatic time switch controls to turn off lights during nonbusiness hours. Timed overrides for any line-up or walk-in case may only be used to turn the lights on for up to one hour. Manual overrides shall time-out automatically to turn the lights off after one hour.

B. Motion sensor controls on each case that reduce display case lighting power by at least 50 percent within 30 minutes after the area near the case is vacated.

4. **Refrigeration heat recovery.**

A. HVAC systems shall utilize heat recovery from refrigeration system(s) for space heating, using no less than 25 percent of the sum of the design total heat of rejection of all refrigeration systems that have individual total heat of rejection values of 150,000 Btu/h or greater at design conditions.

Exception 1 to Section 120.6(b)4A: Stores located in Climate Zone 15.

Exception 2 to Section 120.6(b)4A: HVAC systems or refrigeration systems that are reused for an addition or alteration.

Exception 3 to Section 120.6(b)4A: Stores where the design total heat of rejection of all refrigeration systems is less than or equal to 500,000 Btu/h.

B. The increase in hydrofluorocarbon refrigerant charge associated with refrigeration heat recovery equipment and piping shall be no greater than 0.35 lbs per 1,000 Btu/h of heat recovery heating capacity.

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5. **Transcritical CO_2 gas coolers**. New fan-powered gas coolers on all new transcritical CO_2 refrigeration systems shall conform to the following:
   A. Air-cooled gas coolers are prohibited in Climate Zones 10 through 15.
   B. Design leaving gas temperature for air-cooled gas coolers shall be less than or equal to the design dry-bulb temperature plus 6°F.
   C. Design leaving gas temperature for adiabatic gas coolers necessary to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to the design dry-bulb temperature plus 15°F.
   D. All gas cooler fans shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.
   E. While operating below the critical point, the gas cooler pressure shall be controlled in accordance with Section 120.6(b)1B, 120.6(b)1C, or 120.6(b)1D.
   F. While operating above the critical point, the gas cooler pressure setpoint shall be reset based on ambient conditions such that the system efficiency is maximized.
   G. The minimum condensing temperature setpoint shall be less than or equal to 60°F for air-cooled gas coolers, evaporative-cooled gas coolers, adiabatic gas coolers, air or water-cooled fluid coolers or cooling towers.

      Exception to Section 120.6(b)5G: Transcritical CO_2 refrigeration systems with a design intermediate saturated suction temperature greater than or equal to 30°F shall have a minimum condensing temperature setpoint of 70°F or less.
   H. Fan-powered gas coolers shall meet the condenser efficiency requirements listed in Table 120.6-E. Gas cooler efficiency is defined as the total heat of rejection (THR) capacity divided by all electrical input power (fan power at 100-percent fan speed).

TABLE 120.6-E—TRANSCRITICAL CO_2 FAN-POWERED GAS COOLERS—MINIMUM EFFICIENCY REQUIREMENTS

CONDENSER TYPE	REFRIGERANT TYPE	MINIMUM EFFICIENCY	RATING CONDITION
Outdoor air cooled	Transcritical CO_2	160 Btuh/watt	1400 psig, 100°F outlet gas temperature, 90°F outdoor dry-bulb temperature
Adiabatic dry mode	Transcritical CO_2	90 Btuh/watt	1100 psig, 100°F outlet gas temperature, 90°F outdoor dry-bulb temperature

6. **Commercial refrigeration acceptance.** Before an occupancy permit is granted for a new retail food or beverage store, or before a new refrigeration system serving a retail food or beverage store is operated for normal use, the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements. Transcritical CO_2 refrigeration systems shall be tested in accordance with NA7.20.1.

(c) **Mandatory requirements for enclosed parking garages.**

Mechanical ventilation systems for enclosed parking garages where the total design exhaust rate for the garage is greater than or equal to 10,000 cfm shall conform to all of the following:

1. Automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50 percent or less of design capacity, provided acceptable contaminant levels are maintained.
2. Have controls and/or devices that will result in fan motor demand of no more than 30 percent of design wattage at 50 percent of design airflow.
3. CO shall be monitored with at least one sensor per 5,000 square feet, with the sensor located in the highest expected concentration locations, with at least two sensors per proximity zone. A proximity zone is defined as an area that is isolated from other areas either by floor or other impenetrable obstruction.
4. CO concentration at all sensors is maintained at ≤ 25 ppm or less at all times.
5. The ventilation rate shall be at least 0.15 cfm/ft^2 when the garage is scheduled to be occupied.
6. The system shall maintain the garage at negative or neutral pressure relative to other occupiable spaces when the garage is scheduled to be occupied.
7. CO sensors shall be:
   A. Certified by the manufacturer to be accurate within plus or minus 5 percent of measurement.
   B. Factory calibrated.
   C. Certified by the manufacturer to drift no more than 5 percent per year.
   D. Certified by the manufacturer to require calibration no more frequently than once a year.

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E. Monitored by a control system. The system shall have logic that automatically checks for sensor failure by the following means. Upon detection of a failure, the system shall reset to design ventilation rates and transmit an alarm to the facility operators.

i. If any sensor has not been calibrated according to the manufacturer's recommendations within the specified calibration period, the sensor has failed.

ii. During unoccupied periods the system compares the readings of all sensors, e.g., if any sensor is more than 15 ppm above or below the average of all sensors for longer than four hours, the sensor has failed.

iii. During occupied periods the system compares the readings of sensors in the same proximity zone, e.g., if the 30 minute rolling average for any sensor in a proximity zone is more than 15 ppm above or below the 30 minute rolling average for other sensor(s) in that proximity zone, the sensor has failed.

8. **Parking garage ventilation system acceptance.** Before an occupancy permit is granted for a parking garage system subject to Section 120.6(c), the following equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the Reference Nonresidential Appendix NA7. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.12.

Exception 1 to Section 120.6(c): Any garage, or portion of a garage, where more than 20 percent of the vehicles expected to be stored have nongasoline combustion engines.

Exception 2 to Section 120.6(c): Additions and alterations to existing garages where less than 10,000 cfm of new exhaust capacity is being added.

(d) **Mandatory requirements for process boilers.**

1. Combustion air positive shut-off shall be provided on all newly installed process boilers as follows:
   A. All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
   B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).
2. Process boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:
   A. The fan motor shall be driven by a variable speed drive; or.
   B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.
3. Newly installed process boilers with an input capacity greater than 5 MMBtu/h (5,000,000 Btu/h) shall maintain stack-gas oxygen concentrations at less than or equal to 3.0 percent by volume on a dry basis over firing rates of 20 to 100 percent. Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

   Exception to Section 120.6(d)3: Boilers with steady state full-load combustion efficiency 90 percent or higher.

(e) **Mandatory requirements for compressed air systems.**

All new compressed air systems, and all additions or alterations of compressed air systems where the total combined horsepower (hp) of the compressor(s) is 25 hp or more shall meet the requirements of Subsections 1 through 5. These requirements apply to the compressors, related piping systems and related controls that provide compressed air and do not apply to any equipment or controls that use or process the compressed air.

Exception 1 to Section 120.6(e): Medical gas compressed air systems serving healthcare facilities.

1. **Trim compressor and storage.** The compressed air system shall be equipped with an appropriately sized trim compressor and primary storage to provide acceptable performance across the range of the system and to avoid control gaps. The compressed air system shall comply with Subsection A or B below.
   A. The compressed air system shall include one or more variable speed drive (VSD) compressors. For systems with more than one compressor, the total combined capacity of the VSD compressor(s) acting as trim compressors must be at least 1.25 times the largest net capacity increment between combinations of compressors. The compressed air system shall include primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor; or
   B. The compressed air system shall include a compressor or set of compressors with total effective trim capacity at least the size of the largest net capacity increment between combinations of compressors, or the size of the smallest compressor, whichever is larger. The total effective trim capacity of single compressor systems shall cover at least the range from 70 to 100 percent of rated capacity. The effective trim capacity of a compressor is the size of the continuous operational range where the specific power of the compressor (kW/100 acfm) is within 15 percent of the specific power at its most efficient operating point. The total effective trim capacity of the system is the sum of the effective trim capacity of the trim compressors. The system shall include primary storage of at least 2 gallons per acfm of the largest trim compressor.

   Exception 1 to Section 120.6(e)1: Alterations where the total combined added or replaced compressor horsepower is less than the average per-compressor horsepower of all compressors in the system.

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Exception 2 to Section 120.6(e)1: Alterations where all added or replaced compressors are variable speed drive (VSD) compressors and compressed air system includes primary storage of at least one gallon per actual cubic foot per minute (acfm) of the largest trim compressor.

Exception 3 to Section 120.6(e)1: Compressed air systems that have been approved by the Energy Commission Executive Director as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.

Exception 4 to Section 120.6(e)1: Alterations of existing compressed air systems that include one or more centrifugal compressors.

2. **Controls.** Compressed air systems with three or more compressors and a combined horsepower rating of more than 100 hp shall operate with controls that are able to choose the most energy efficient combination and loading of compressors within the system based on the current compressed air demand.
3. **Monitoring.** Compressed air systems having a combined horsepower rating equal to or greater than 100 hp shall have an energy and air demand monitoring system with the following minimum requirements:
   A. Measurement of system pressure.
   B. Measurement of amps or power of each compressor.
   C. Measurement or determination of total airflow from compressors in cfm.
   D. Data logging of pressure, power in kW, airflow in cfm and compressed air system specific efficiency in kW/100 cfm at intervals of 5 minutes or less.
   E. Maintained data storage of at least the most recent 24 months.
   F. Visual trending display of each recorded point, load and specific energy.
4. **Leak testing of compressed air piping.** Compressed air system piping greater than 50 adjoining feet in length shall be pressure tested after being isolated from the compressed air supply and end uses. The piping shall be pressurized to the design pressure and test pressures shall be held for a length of time at the discretion of the authority having jurisdiction, but in no case for less than 30 minutes, with no perceptible drop in pressure.

   If dial gauges are used for conducting this test, these gauges must conform with *California Plumbing Code* Sections 318.3, 318.4 and 318.5.

   Piping less than or equal to 50 adjoining feet in length shall be pressurized and inspected. Connections shall be tested with a noncorrosive leak-detecting fluid or other leak-detecting methods at the discretion of the authority having jurisdiction.
5. **Pipe sizing.** Compressed air piping greater than 50 adjoining feet in length shall be designed and installed to minimize frictional losses in the distribution network. These piping installations shall meet the requirements of Section 120.6(e)5A and either Section 120.6(e)5B or 120.6(e)5C:
   A. Service line piping shall have inner diameters greater than or equal to ¾ inch. Service line piping are pipes that deliver compressed air from distribution piping to end uses.
   B. Piping section average velocity. Compressor room interconnection and main header piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 20 ft/sec. Compressor room interconnection and main header piping are the pipes that deliver compressed air from the compressor outlets to the inlet to the distribution piping. Each segment of distribution and service piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 30 ft/sec. Distribution piping are pipes that deliver compressed air from the compressor room interconnection piping or main header piping to the service line piping.
   C. Piping total pressure drop. Piping shall be designed such that piping frictional pressure loss at coincident peak loads is less than 5 percent of operating pressure between the compressor and end use or end use regulator.
6. **Compressed air system acceptance.** Before an occupancy permit is granted for a compressed air system subject to Section 120.6(e), the equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the Reference Nonresidential Appendix NA7. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA 7.13.

(f) **Mandatory requirements for elevators.** Elevators shall meet the following requirements:

1. The light power density for the luminaires inside the elevator cab shall be no greater than 0.6 watts per square foot.

   Exception to Section 120.6(f)1: Interior signal lighting and interior display lighting are not included in the calculation of lighting power density.
2. Elevator cab ventilation fans for cabs without space conditioning shall not exceed 0.33 watts per cfm as measured at maximum speed.
3. When the elevator cab is stopped and unoccupied with doors closed for over 15 minutes, the cab interior lighting and ventilation fans shall be switched off until elevator cab operation resumes.
4. Lighting and ventilation shall remain operational in the event that the elevator cabin gets stuck when passengers are in the cabin.
5. Elevator Lighting and Ventilation Control Acceptance. Before an occupancy permit is granted for elevators subject to 120.6(f), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compli-

ance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.14.

Exception to Section 120.6(f): Elevators located in healthcare facilities.

(g) **Mandatory requirements for escalators and moving walkways**.

1. Escalators and moving walkways located in airports, hotels, and transportation function areas shall automatically slow to the minimum permitted speed in accordance with ASME A17.1/CSA B44 when not conveying passengers.
2. Escalators and Moving Walkways Acceptance. Before an occupancy permit is granted for escalators and moving walkways subject to 120.6(g), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.15.

(h) **Mandatory requirements for controlled environment horticulture (CEH) spaces.**

1. **Indoor growing, dehumidification.** Dehumidification equipment shall be one of the following:
   A. Dehumidifiers subject to regulation under federal appliance standards tested in accordance with 10 CFR 430.23(z) and Appendix X or X1 to Subpart B of 10 CFR Part 430 as applicable, and complying with 10 CFR 430.32(v)2;
   B. Integrated HVAC system with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat;
   C. Chilled water system with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat; or
   D. Solid or liquid desiccant dehumidification system for system designs that require dew point of 50°F or less.
2. **Indoor growing, electrical power distribution systems.** Electrical power distribution systems serving CEH spaces shall be designed so that a measurement device is capable of monitoring the electrical energy usage of aggregate horticultural lighting load.
3. **Conditioned greenhouses, building envelope.** Conditioned greenhouses shall meet the following requirements:
   A. Opaque wall and opaque roof assembly shall meet the requirements of Section 120.7; and
   B. Nonopaque envelopes shall have two or more glazings separated by either air or gas fill.
4. **Conditioned greenhouses, space-conditioning systems.** Space-conditioning systems used for plant production shall comply with all applicable requirements.
5. **Horticultural lighting.** In a building with CEH spaces or a greenhouse with more than 40 kW of aggregate horticultural lighting load, the electric lighting system used for plant growth and plant maintenance shall meet the following requirements:
   A. The horticultural lighting systems shall have a photosynthetic photon efficacy (PPE) rated in accordance with ANSI/ASABE S640 for wavelengths from 400 to 700 nanometers and meet one of the following requirements:
      i. Integrated, nonserviceable luminaires shall have a rated PPE of at least 2.3 micromoles per joule; or
      ii. Luminaires with removable or serviceable lamps shall have lamps with a rated PPE of at least 2.3 micromoles per joule.
   B. Time-switch lighting controls shall be installed and comply with Section 110.9(b)1, Section 130.4(a)4 and applicable sections of Reference Nonresidential Appendix NA7.6.2.
   C. Multilevel lighting controls shall be installed and comply with Section 130.1(b).

(i) **Mandatory requirements for steam traps.** Steam traps in new industrial facilities and new steam traps added to support new, nonreplacement, process equipment in existing industrial facilities where the installed steam trap operating pressure, which is the steam pressure entering the steam trap during normal design operating conditions, is greater than 15 psig and the total combined connected boiler input rating is greater than 5 million Btu/hr shall meet the following requirements:

1. **Central steam trap fault detection and diagnostics monitoring.** Steam trap systems shall be equipped with a central steam trap monitoring system that:
   A. Provides a status update of all steam trap fault detection sensors at no greater than 8-hour intervals.
   B. Automatically displays an alarm that identifies which steam trap has a fault once the system has detected a fault.
2. **Steam trap fault detection.** Steam traps shall be equipped with automatic fault detection sensors that shall communicate their operational state to the central steam trap monitoring system as described in Section 120.6(i)1.
3. **Steam trap strainer installation.** Steam traps shall either:
   A. Be equipped with an integral strainer and blow-off valve; or
   B. Be installed downstream within 3 feet of a strainer and blow-off valve.
4. **Steam trap system acceptance.** Before an occupancy permit is granted for steam trap systems subject to Section 120.6(i), the equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.19. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.19.

Exception 1 to Section 120.6(i): Steam traps where steam is diverted to a steam system of lower pressure for use when the steam trap fails open.

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(j) **Mandatory requirements for computer rooms.** Space-conditioning systems serving a computer room shall meet the following requirements:

1. **Reheat.** Each computer room zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.
2. **Humidification.** Humidification shall be adiabatic. Nonadiabatic humidification, including but not limited to steam and infrared, is prohibited.
3. **Fan control.** Each unitary air conditioner with mechanical cooling capacity exceeding 60,000 Btu/hr and each chilled water fan system shall be designed to vary the airflow rate as a function of actual load. Fan motor demand shall not exceed 50 percent of design wattage at 66 percent of design fan speed.

(k) **Mandatory requirements for commercial kitchens.** Electric readiness for newly constructed commercial kitchens shall meet the following requirements:

1. Quick-service commercial kitchens and institutional commercial kitchens shall include a dedicated branch circuit wiring and outlet that would be accessible to cookline appliances and shall meet all of the following requirements:
   A. The branch circuit conductors shall be rated at 50 amps minimum.
   B. The electrical service panel shall have a minimum capacity of 800 connected amps.
2. The electrical service panel shall be sized to accommodate an additional either 208V or 240V 50-amp breaker.

Exception 1 to Section 120.6(k): Healthcare facilities.

Exception 2 to Section 120.6(k): All-electric commercial kitchens.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.7—MANDATORY REQUIREMENTS FOR BUILDING ENVELOPES

Nonresidential and hotel/motel buildings shall comply with the applicable requirements in Sections 120.7(a) through 120.7(e).

(a) **Roof/Ceiling insulation.** The opaque portions of the roof/ceiling that separates conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:

1. **Metal building.** The weighted average *U*-factor of the roof assembly shall not exceed 0.098.
2. **Wood framed and others.** The weighted average *U*-factor of the roof assembly shall not exceed 0.075.
3. **Insulation placement.** Insulation installed to limit heat loss and gain from conditioned spaces to unconditioned spaces shall comply with all of the following:
   A. Insulation shall be installed in direct contact with a roof or ceiling that is sealed to limit infiltration and exfiltration as specified in Section 110.7. This may include, but is not limited to, placing insulation either above or below the roof deck or on top of the finished ceiling.
   B. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed. When the space between the ceiling and the roof is either directly or indirectly conditioned space, it shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements.
   C. Insulation placed on top of a suspended ceiling with removable ceiling panels shall not be used to meet the Roof/Ceiling requirement of Sections 140.3 and 141.0.

   Exception to Section 120.7(a)3: When there are conditioned spaces with a combined floor area no greater than 2,000 square feet in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 feet, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

Note: Vents that do not penetrate the roof deck and are instead designed for wind resistance for roof membranes are not within the scope of Section 120.7(a)3B.

(b) **Wall insulation.** The opaque portions of walls that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 7 below:

1. **Metal building.** The weighted average *U*-factor of the wall assembly shall not exceed 0.113.
2. **Metal framed.** The weighted average *U*-factor of the wall assembly shall not exceed 0.151.
3. **Light mass walls.** A 6-inch or greater hollow core concrete masonry unit shall have a *U*-factor not to exceed 0.440.
4. **Heavy mass walls.** An 8-inch or greater hollow core concrete masonry unit shall have a *U*-factor not to exceed 0.690.
5. **Wood framed and others.** The weighted average *U*-factor of the wall assembly shall not exceed 0.110.
6. **Spandrel panels and curtain wall.** The weighted average *U*-factor of the spandrel panels and curtain wall assembly shall not exceed 0.280.
7. **Demising walls.** The opaque portions of framed demising walls shall meet the requirements of Item A or B below:
   A. Wood framed walls shall be insulated to meet a *U*-factor not greater than 0.099.

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B. Metal framed walls shall be insulated to meet a *U*-factor not greater than 0.151.

(c) **Floor and soffit insulation.** The opaque portions of floors and soffits that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 and 2 below:

1. **Raised mass floors.** Shall have a minimum of 3 inches of lightweight concrete over a metal deck, or the weighted average *U*-factor of the floor assembly shall not exceed 0.269.
2. **Other floors.** The weighted average *U*-factor of the floor assembly shall not exceed 0.071.
3. **Heated slab on grade floor.** A heated slab on grade floor shall be insulated to meet the requirements of Section 110.8(g).

Exception to Section 120.7: A dedicated building used solely as a data center that has a total covered process load exceeding 750 kW.

(d) **Exterior windows.** Vertical fenestration assemblies shall have an area weighted average *U*-factor no greater than 0.47.

Exception to Section 120.7(d): Fenestration installed in buildings meeting Part 7 of the *California Building Code, California Wildland-Urban Interface Code*, and where the building is located in Fire Hazard Severity Zones or Wildland-Urban Interface (WUI) Fire Areas as designated by the local enforcement agency.

(e) **Vestibules.** Public entrances in newly constructed buildings of Group A, B, E, I, and M ocupancies shall include an enclosed vestibule meeting the applicable requirements of Items 1 and 2 below:

1. All doors opening into and out of the vestibule shall be equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any main entrance doors adjacent to revolving doors.
2. Where provided, the heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F. Vestibules heating and cooling systems shall be controlled by a thermostat located in the vestibule which is configured to limit heating to a temperature not greater than 60°F and cooling to a temperature not less than 85°F.

Exceptions to Section 120.7(e): Vestibules are not required for the following:

1. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
2. Doors opening directly from a sleeping unit or dwelling unit.
3. Doors that open directly from a space less than 3,000 square feet in area.
4. Revolving doors installed where a public entrance to a newly constructed building is required.
5. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
6. Doors that have an air curtain with a velocity of not less than 6.56 feet per second at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that operate the air curtain with the opening and closing of the door.
7. Public entrances in buildings that are located in Climate Zones 2 through 13 where the building is less than four stories above grade and less than 10,000 square feet of gross conditioned floor area.
8. Buildings with building plans that have been submitted to the local planning department before the effective date of the 2025 Building Energy Efficiency Standards, where compliance with the vestibule requirements of Section 120.7(e) would require a resubmittal for approval.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code*.

SECTION 120.8—NONRESIDENTIAL BUILDING COMMISSIONING

Nonresidential buildings other than healthcare facilities, with conditioned space of 10,000 square feet or more, shall comply with the applicable requirements of Sections 120.8(a) through 120.8(i) in the building design and construction processes. All building systems and components covered by Sections 110.0, 120.0, 130.0, and 140.0 shall be included in the scope of the commissioning requirements in this Section, excluding those related solely to covered processes.

Nonresidential buildings other than healthcare facilities, with conditioned space of less than 10,000 square feet shall comply with the design review requirements specified in Sections 120.8(d), and shall include any measures or requirements necessary for completing this review in the construction documents in a manner consistent with Section 120.8(e).

Healthcare facilities shall instead comply with the applicable requirements of Chapter 7 of the *California Administrative Code* (Title 24, Part 1).

NOTE: Nonresidential buildings include nonresidential spaces such as nonresidential function areas within hotel/motel and high-rise residential buildings. The requirements of Section 120.8 apply based on the square footage of the nonresidential spaces.

The commissioning described in this Section is in addition to any commissioning required by Title 24, Part 11, Section 5.410.2, 5.410.4 and subsections.

(a) **Summary of commissioning requirements.** Commissioning shall include completion of the following items:

1. Owner's or owner representative's project requirements;

2. Basis of design;
3. Design phase design review;
4. Commissioning measures shown in the construction documents;
5. Commissioning plan;
6. Functional performance testing;
7. Documentation and training; and
8. Commissioning report.

(b) **Owner's or Owner Representative's Project Requirements (OPR).** The energy-related expectations and requirements of the building shall be documented before the design phase of the project begins. This documentation shall include the following:

1. Energy efficiency goals;
2. Ventilation requirements;
3. Project documentation requirements, including facility functions, hours of operation, and need for after-hours operation;
4. Equipment and systems expectations; and
5. Building envelope performance expectations.

(c) **Basis of design (BOD).** A written explanation of how the design of the building systems and components meets the OPR shall be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The basis of design document shall cover the following systems and components:

1. Heating, ventilation, air conditioning (HVAC) systems and controls;
2. Indoor lighting system and controls;
3. Water heating systems and controls;
4. Any other building equipment or system listed in the OPR; and
5. Any building envelope component considered in the OPR.

(d) **Design phase design review.**

1. **Design reviewer requirements.** The design reviewer shall be the signer of the Design Review Kickoff Certificate(s) of Compliance and Construction Document Design Review Checklist Certificate(s) of Compliance as specified in Part 1 Section 10-103(a)1.
2. **Design review kickoff.** During the schematic design phase of the building project, the owner or owner's representative, design team and design reviewer must meet to discuss the project scope, schedule and how the design reviewer will coordinate with the project team. The building owner or owner's representative shall include the Design Review Kickoff Certificate of Compliance form in the certificate of compliance documentation (as specified in Part 1 Section 10-103).
3. **Construction documents design review.** The construction documents design review Checklist Certificate of Compliance shall list the items checked by the design reviewer during the construction document review. The completed form shall be returned to the owner and design team for review and sign-off. The building owner or owner's representative shall include this form in the certificate of compliance documentation (as specified in Part 1 Section 10-103).

(e) **Commissioning measures shown in the construction documents.** Complete descriptions of all measures or requirements necessary for commissioning shall be included in the construction documents (plans and specifications). Commissioning measures or requirements shall be clear, detailed and complete to clarify the commissioning process.

(f) **Commissioning plan.** Prior to permit issuance a commissioning plan shall be completed to document how the project will be commissioned and shall be started during the design phase of the building project. The commissioning plan shall include the following:

1. General project information;
2. Commissioning goals;
3. Systems to be commissioned; and
4. Plans to test systems and components, which shall include:
   A. An explanation of the original design intent;
   B. Equipment and systems to be tested, including the extent of tests;
   C. Functions to be tested;
   D. Conditions under which the test shall be performed;
   E. Measurable criteria for acceptable performance;
   F. Commissioning team information; and
   G. Commissioning process activities, schedules and responsibilities. Plans for the completion of commissioning requirements listed in Sections 120.8(g) through 120.8(i) shall be included.

(g) **Functional performance testing.** Functional performance tests shall demonstrate the correct installation and operation of each component, system and system-to-system interface in accordance with the acceptance test requirements in Sections 120.5, 130.4, 140.9, 160.3(d) and 160.5(e). Functional performance testing reports shall contain information addressing each of the building components tested, the testing methods utilized, and include any readings and adjustments made.

Exception to Section 120.8(g): Healthcare facilities.

(h) **Documentation and training.** A systems manual and systems operations training shall be completed.

1. **Systems manual.** Documentation of the operational aspects of the building shall be completed within the systems manual and delivered to the building owner or representative and facilities operator. The systems manual shall include the following:
   A. Site information, including facility description, history and current requirements;
   B. Site contact information;
   C. Instructions for basic operations and maintenance, including general site operating procedures, basic troubleshooting, recommended maintenance requirements, and a site events log;
   D. Description of major systems;
   E. Site equipment inventory and maintenance notes; and
   F. A copy of all special inspection verifications required by the enforcing agency or the standards.
2. **Systems operations training.** The training of the appropriate maintenance staff for each equipment type or system shall be documented in the commissioning report. Training materials shall include the following:
   A. System and equipment overview (i.e., what the equipment is, what it does and with what other systems or equipment it interfaces);
   B. Review and demonstration of operation, servicing and preventive maintenance procedures;
   C. Review of the information in the systems manual; and
   D. Review of the record drawings on the systems and equipment.

(i) **Commissioning report.** A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for post- construction phases of the building project shall be completed and provided to the owner or owner's representative.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.9—MANDATORY REQUIREMENTS FOR COMMERCIAL BOILERS

(a) Combustion air positive shut-off shall be provided on all newly installed boilers as follows:

1. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
2. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

(b) Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

1. The fan motor shall be driven by a variable speed drive, or
2. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

(c) Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain stack-gas oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

Exception to Section 120.9(c): Boilers with steady state full-load combustion efficiency 90 percent or higher.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

SECTION 120.10—MANDATORY REQUIREMENTS FOR FANS

(a) Each fan or fan array with a combined motor nameplate horsepower greater than 1.00 hp or with a combined fan nameplate electrical input power greater than 0.89 kW shall have a fan energy index (FEI) of 1.00 or higher at fan system design conditions. Each fan and fan array used for a variable-air-volume system that meets the requirements of Section 140.4(c)2 shall have an FEI of 0.95 or higher at fan system design conditions.

1. The FEI for fan arrays shall be calculated in accordance with ANSI/AMCA 208-18 Annex C.
2. All FEI values shall be provided by a manufacturer, where fan selection software and/or fan catalogs display third-party-verified FEI values in accordance with Appendix A to Subpart J of Part 10 CFR 431.

   Exception to Section 120.10(a)2: FEI values for embedded fans do not need to be third-party verified.

Exception 1 to Section 120.10(a): Embedded fans that are part of the equipment listed under Section 110.1 or Section 110.2, computer room air conditioners (CRACs) as defined in 10 CFR 431, and DX-DOAS units.

Exception 2 to Section 120.10(a): Embedded fans and embedded fan arrays with a combined motor nameplate horsepower of 5 hp or less or with a fan system electrical input power of 4.1 kW or less.

Exception 3 to Section 120.10(a): Circulation fans, ceiling fans and air curtains.

Exception 4 to Section 120.10(a): Fans that are intended to operate only during emergency conditions.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8 and 25943, *Public Resources Code*.

SUBCHAPTER

4

NONRESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—MANDATORY REQUIREMENTS FOR LIGHTING SYSTEMS AND EQUIPMENT, AND ELECTRICAL POWER DISTRIBUTION SYSTEMS

SECTION 130.0—LIGHTING SYSTEMS AND EQUIPMENT, AND ELECTRICAL POWER DISTRIBUTION SYSTEMS—GENERAL

(a) The design and installation of all lighting systems and equipment in nonresidential and hotel/motel buildings, outdoor lighting, and electrical power distribution systems within the scope of Section 100.0(a), shall comply with the applicable provisions of Sections 130.0 through 130.5.

(b) **Functional areas where compliance with the residential lighting standards is required.** The design and installation of all lighting systems, lighting controls and equipment in the following functional areas shall comply with the applicable residential lighting requirements of Section 150.0(k). In buildings containing these functional areas, all other functional areas, such as common areas, shall comply with the applicable nonresidential lighting and controlled receptacle requirements.

1. **Reserved.**
2. Outdoor lighting attached to a hotel/motel building and separately controlled from the inside of a guest room.
3. Fire station dwelling accommodations.
4. Hotel and motel guest rooms. Additionally, hotel and motel guest rooms shall meet the requirements of Section 130.1(c)8 and Section 130.5(d)4.
5. **Reserved.**

(c) **Luminaire classification and power.** Luminaires classified and their wattage shall be determined as follows:

1. Luminaire wattage shall be labeled as follows:
   A. The maximum rated wattage or relamping rated wattage of a luminaire shall be listed on a permanent, preprinted, factory installed label, as specified by UL 1574, 1598, 2108 or 8750, as applicable; and
   B. The factory-installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the luminaire has been shipped from the manufacturer.

   Exception to Section 130.0(c)1B: Peel-down labels may be used only for the following luminaires, when they can accommodate a range of lamp wattages without changing the luminaire housing, ballast, transformer or wiring. Qualifying luminaires shall have a single lamp, and shall have integrated ballasts or transformers. Peel-down labels must be layered such that the rated wattage reduces as successive layers are removed.
      i. High-intensity discharge luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.
      ii. Low-voltage luminaires (except low voltage track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.
      iii. Compact fluorescent luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.
2. For luminaires with line voltage lamp holders not served by drivers, ballasts, or transformers; the wattage of such luminaires shall be determined as the maximum relamping rated wattage as labeled in accordance with Section 130.0(c)1.
3. For luminaires with permanently installed or remotely installed ballasts, the wattage of such luminaires shall be the operating input wattage of the rated lamp/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by UL 1598.
4. For inseparable SSL luminaires and SSL luminaires with remotely mounted drivers, the maximum rated wattage shall be the maximum rated input wattage of the SSL luminaire as specified in Section 130.0(c)1 when tested in accordance with UL 1598, 2108 or 8750, or IES LM-79.
5. For LED tape lighting and LED linear lighting with LED tape lighting components, the maximum rated wattage shall be the sum of the installed length of the tape lighting times its rated linear power density in watts per linear feet, or the maximum rated input wattage of the driver or power supply providing power to the lighting system, with tape lighting tested in accordance with UL 2108 or 8750, or IES LM-79.
6. For modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the system, wattage shall be determined as follows:
   A. The wattage shall be the greater of:
      i. 30 watts per linear foot of track or plug-in busway; or
      ii. the rated wattage of all of the luminaires included in the system, where the luminaire wattage is determined as specified in Section 130.0(c)1.

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B. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:
   i. The volt-ampere rating of the current limiter as specified by UL 1077; or
   ii. The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for track lighting supplementary overcurrent protection panel.

C. For other modular lighting systems with power supplied by a driver, power supply or transformer, including but not limited to low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformer published in the manufacturer's catalogs, as specified by UL 2108 or 8750.

Exception to Section 130.0(c)6: For power-over-Ethernet lighting systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

7. For all other lighting equipment not addressed by Sections 130.0(c)2 through 6, the wattage of the lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, labeled in accordance with Section 130.0(c)1, or published in manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574, 1598, 2108 or 8750, or IES LM-79.

(d) **Lighting controls.** All lighting controls and equipment shall comply with the applicable requirements in Sections 110.9, 130.1 and 130.2, and shall be installed in accordance with any applicable manufacturer instructions.

(e) **Energy Management Control System (EMCS).** An EMCS may be installed to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:

1. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Sections 110.9, 130.1 and 130.2; and
2. Complies with all applicable lighting control installation requirements in accordance with Section 130.4 for each specific lighting control or system for which it is installed; and
3. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 130.1—MANDATORY INDOOR LIGHTING CONTROLS

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 130.1(a) through 130.1(f), in addition to the applicable requirements of Sections 110.9 and 130.0.

(a) **Manual controls.** Each space shall be provided with lighting controls that allow the lighting in that space to be manually turned on and off. The manual control shall:

1. Be readily accessible; and

   Exception to Section 130.1(a)1: Restrooms having two or more stalls, parking areas, stairwells, corridors and spaces of the building intended for access or use by the public may use a manual control not accessible to unauthorized personnel.

2. Be located in the same space, or be located such that the controlled lighting or the status of the controlled lighting can be seen when operating the controls; and

   Exception to Section 130.1(a)2: In healthcare facilities, for restrooms and bathing rooms intended for a single occupant, the lighting control may be located outside the enclosed area but directly adjacent to the door.

3. Provide separate control of general, floor display, wall display, window display, case display, ornamental, and special effects lighting, such that each type of lighting can be turned on or off without turning on or off other types of lighting. Scene controllers may comply with this requirement provided that at least one scene turns on general lighting only, and the control provides a means to manually turn off all lighting.

Exception to Section 130.1(a): Up to 0.1 watts per square foot of indoor lighting may be continuously illuminated to allow for means of egress illumination consistent with *California Building Code* Section 1008. Egress lighting complying with this wattage limitation is not required to comply with manual control requirements if:

1. The space is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1; and
2. The egress lighting controls shall not be controllable by unauthorized personnel during a normal power failure.

(b) **Multilevel lighting controls.** The general lighting of any space with a size of 100 square feet or larger and with a connected lighting load greater than 0.5 watts per square foot shall be provided with multilevel lighting controls. The multilevel lighting controls shall provide and enable continuous dimming from 100 percent to 10 percent or lower of lighting power.

Exception 1 to Section 130.1(b): An indoor space that has only one luminaire.

Exception 2 to Section 130.1(b): Restrooms.

Exception 3 to Section 130.1(b): Healthcare facilities.

Exception 4 to Section 130.1(b): The general lighting with light source of HID and induction shall have a minimum of one control step between 30 and 70 percent of full rated power.

(c) **Shut-OFF Controls.** All installed indoor lighting shall be equipped with controls able to automatically reduce lighting power when the space is typically unoccupied.

Exception 1 to Section 130.1(c): Healthcare facilities.

Exception 2 to Section 130.1(c): Continuous illumination of up to 0.1 watts per square foot in any area designated for egress within a building is allowed, provided that the area is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1. The lighting provided for means of egress illumination, as defined in the *California Building Code,* must be configured to provide no less than the illumination required by *California Building Code* Section 1008 while in the partial-off mode.

1. All installed indoor lighting shall be equipped with controls that meet the following requirements:
   A. Shall be controlled with an occupant sensing control set to no more than a 20-minute time delay, automatic time-switch control, or other control capable of automatically shutting OFF all of the lighting when the space is typically unoccupied; and
   B. Separate controls for the lighting on each floor, other than lighting in stairwells; and
   C. Separate control zones for a space enclosed by ceiling height partitions not exceeding 5,000 square feet.

      Exception to Section 130.1(c)1C: The area controlled may not exceed 20,000 square feet in the following function areas: malls, auditoriums, single tenant retail, industrial, convention centers and arenas.

   Exception 1 to Section 130.1(c)1: Where the lighting is serving an area that is in continuous use, 24 hours per day/365 days per year.

   Exception 2 to Section 130.1(c)1: Lighting complying with Section 130.1(c)5 or 130.1(c)6E. Lighting in stairwells and common area corridors that provide access to guestrooms of hotel/motels and complying with Section 130.1(c)6C.

   Exception 3 to Section 130.1(c)1: Electrical equipment rooms subject to Article 110.26(D) of the *California Electrical Code.*

   Exception 4 to Section 130.1(c)1: Illumination provided by lighting equipment that is designated for emergency lighting, and is intended to function in emergency mode only when normal power is absent.
2. Countdown timer switches may be used to comply with the automatic shut-OFF control requirements in Section 130.1(c)1 only in closets less than 70 square feet, and server aisles in server rooms. The maximum timer setting shall be 10 minutes for closets, and 30 minutes for server aisles.
3. If an automatic time-switch control is installed to comply with Section 130.1(c)1, it shall incorporate a manual override lighting control that allows the lighting to remain ON for no more than 2 hours when an override is initiated.

   Exception 1 to Section 130.1(c)3: In the following function areas, the override time may exceed 2 hours: Malls, auditoriums, single tenant retail, industrial, laboratories and arenas where captive-key override is utilized.

   Exception 2 to Section 130.1(c)3: Areas where occupant sensing controls are installed.
4. If an automatic time-switch control is installed to comply with Section 130.1(c)1, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

   Exception 1 to Section 130.1(c)4: Automatic holiday shut-off features are not required in retail stores, malls, restaurants, grocery stores, churches, and theaters.

   Exception 2 to Section 130.1(c)4: Areas where occupant sensing controls are installed.
5. **Occupant sensing controls.** In offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, classrooms, conference rooms, and restrooms, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting in 20 minutes or less after the control zone is unoccupied.

   In areas required by Section 130.1(b) to have multi-level lighting controls, the occupant sensing controls shall function either as a:
   A. Partial-ON occupant sensing controls capable of automatically activating between 50 and 70 percent of controlled lighting power, or
   B. Vacancy sensing controls, where all lighting responds to a manual ON input only.

   In areas not required by Section 130.1(b) to have multilevel lighting controls, the occupant sensing controls shall function either as:
   A. Automatic full-on occupant sensing controls; or
   B. Partial-ON occupant sensing controls, or
   C. Vacancy sensing controls, where all lighting responds to a manual ON input only.

   In addition, controls shall be provided that allow the lights to be manually shut OFF in accordance with Section 130.1(a) regardless of the sensor status.
6. **Full or partial-OFF occupant sensing controls.** For warehouse aisle ways, warehouse open areas, library book stack aisles, corridors, stairwells, offices greater than 250 square feet, parking garages, parking areas, loading areas, and unloading areas, the installed lighting shall meet the following requirements:
   A. In warehouse aisle ways and warehouse open areas, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant

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sensing controls shall independently control lighting in each warehouse aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

Exception to Section 130.1(c)6A: When metal halide lighting or high pressure sodium lighting is installed in warehouses, occupant sensing controls shall reduce lighting power by at least 40 percent.

B. In library book stack aisles 10 feet or longer that are accessible from only one end, and library book stack aisles 20 feet or longer that are accessible from both ends, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall independently control lighting in each aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

C. In corridors and stairwells, lighting shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress. Lighting in stairwells and common area corridors that provide access to guestrooms of hotel/motels shall meet the requirements of this section instead of complying with Section 130.1(c)1.

D. In office spaces greater than 250 square feet, general lighting shall be controlled with occupant sensing controls that meet all of the following:

i. The occupant sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. All control zones in offices greater than 250 square feet shall be shown on the plans; and

ii. In 20 minutes or less after the control zone is unoccupied, the occupant sensing controls shall uniformly reduce lighting power in the control zone to no more than 20 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and

iii. In 20 minutes or less after the entire office space is unoccupied, the occupant sensing controls shall automatically turn off lighting in all control zones in the space; and

iv. In each control zone, lighting shall be allowed to automatically turn on to any level up to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the space, the lighting in other control zones that are unoccupied shall operate at no more than 20 percent of full power.

Exception to Section 130.1(c)6D: Under-shelf or furniture-mounted task lighting controlled by a local switch and either a time switch or an occupancy sensor.

E. In parking garages, parking areas and loading and unloading areas, general lighting shall be controlled by occupant sensing controls that meet the requirements below instead of complying with Section 130.1(c)1:

i. The occupant sensing controls shall uniformly reduce lighting power in the control zone to between 20 percent and 50 percent of full power and with at least one control step; and

ii. No more than 500 watts of rated lighting power shall be controlled together as a single zone; and

iii. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled zone and shall be automatically activated from all designed paths of egress.

Interior areas of parking garages are under the classification of indoor lighting and shall comply with Section 130.1(c)6E. Parking areas on the roof of a parking structure are under the classification of outdoor hardscape and shall comply with Section 130.2.

7. **Reserved.**

8. Hotel/motel guest rooms shall be controlled with one of the following controls such that, no longer than 20 minutes after the guest room has been vacated, lighting power is switched off:

i. Captive card key controls; or

ii. Occupant sensing controls; or

iii. Other automatic controls.

Exception to Section 130.1(c)8: A high-efficacy luminaire that meets the requirements in Section 150.0(k)1A and that is switched separately with the switch located within 6 feet of the entry door.

(d) **Daylight responsive controls.**

1. Daylight responsive controls shall be installed in the following locations as applicable:

A. In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within skylit daylit zones is 75 watts or greater, the general lighting in the skylit daylit zones shall be controlled by daylight responsive controls.

B. In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within primary sidelit daylit zones is 75 watts or greater, the general lighting in the primary sidelit daylit zones shall be controlled by daylight responsive controls.

C. In any enclosed space where the total wattage of general lighting luminaires in the secondary zones is 75 watts or greater, the general lighting in the secondary sidelit daylit zones shall be controlled by daylight responsive controls. General lighting in the secondary sidelit daylit zones shall be controlled independently of general lighting in the primary sidelit daylit zones.

D. For skylights located in an atrium, the skylit daylit zone definition shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

E. Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is 60 watts or greater, the general lighting in the primary and secondary sidelit daylit zones shall be controlled by daylight responsive controls.

2. All daylight responsive controls shall meet the following requirements:

A. All skylit daylit zones, primary sidelit daylit zones, secondary sidelit daylit zones, and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans; and

Note: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

B. The daylight responsive controls shall provide separate control for general lighting in each type of daylit zone. The daylight responsive controls shall meet the following:

i. General lighting in overlapping skylit daylit zone and sidelit daylit zone shall be controlled as part of the skylit daylit zone.

ii. General lighting in overlapping primary and secondary sidelit daylit zones shall be controlled as part of the primary sidelit daylit zone.

iii. General lighting luminaires longer than 8 feet shall be controlled as segments of 8 feet or less according to the type of the daylit zone in which the segment is primarily located; and

Exception to Section 130.1(d)2Biii: Where a luminaire contains a factory assembled housing and light source as an integral unit in segments longer than 8 feet, the luminaire segment is allowed to be controlled according to the type of the daylit zone in which the segment is primarily located.

C. The daylight responsive controls shall meet the following:

i. For spaces where the installation of multilevel lighting controls is required under Section 130.1(b), allow the multilevel lighting controls to adjust the light level with continuous dimming;

ii. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

iii. For areas other than parking garages, ensure that, when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and

iv. For parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylit zones shall be reduced by 100 percent; and

D. Photosensors shall be located so that they are not readily accessible to unauthorized personnel; and

E. The location where calibration adjustments are made to the daylight responsive controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access; and

F. The automatic daylighting control shall permit the multilevel lighting control to adjust the level of lighting.

Exception 1 to Section 130.1(d): Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

Exception 2 to Section 130.1(d): Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for south, east and west orientations or greater than 1 for north orientations.

Exception 3 to Section 130.1(d): Where daylight responsive controls are not required for the primary sidelit daylit zones, and where the total wattage of general lighting luminaires in the secondary sidelit daylit zones is less than 85 watts, daylight responsive controls are not required for the secondary sidelit zone.

Exception 4 to Section 130.1(d): Reserved.

Exception 5 to Section 130.1(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

Exception 6 to Section 130.1(d): For parking garages, luminaires located in the daylight adaptation zone.

Exception 7 to Section 130.1(d): Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

(e) **Demand responsive controls.** See Section 110.12 for requirements for demand responsive lighting controls.

(f) **Occupancy sensing controls interactions with space-conditioning systems.** For space-conditioning system zones serving only spaces that are required to have occupant sensing controls as specified in Sections 130.1(c)5 and 6, and where Table 120.1-A allows the ventilation air to be reduced to zero when the space is in occupied-standby mode, the space-conditioning system shall be permitted to be controlled by occupancy sensing controls as specified in Section 120.2(e)3.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

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SECTION 130.2—OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 130.2(a) through 130.2(c).

(a) **Reserved.**

(b) **Luminaire shielding requirements.** All outdoor luminaires of 6,200 initial luminaire lumens or greater shall comply with backlight, uplight and glare (BUG) (in accordance with ANSI/IES TM-15-20, Annex A) requirements in accordance with Title 24, Part 11, Section 5.106.8.

Exception 1 to Section 130.2(b): Signs.

Exception 2 to Section 130.2(b): Lighting for building facades, public monuments, public art, statues and vertical surfaces of bridges.

Exception 3 to Section 130.2(b): Lighting not permitted by a health or life safety statute, ordinance or regulation to be a cutoff luminaire.

Exception 4 to Section 130.2(b): Temporary outdoor lighting.

Exception 5 to Section 130.2(b): Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 130.2(b); and
B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and
C. Where no additional poles are being added to the site; and
D. Where new wiring to the luminaires is not being installed; and
E. Provided that the connected lighting power wattage is not increased.

Exception 6 to Section 130.2(b): Luminaires that illuminate the public right of way including publicly-maintained or utility-maintained roadways, sidewalks and bikeways.

Exception 7 to Section 130.2(b): Outdoor lighting attached to a hotel/motel building and separately controlled from the inside of a guest room.

Exception 8 to Section 130.2(b): Luminaires that qualify as exceptions in Section 5.106.8 of Part 11 of Title 24 and in Section 140.7(a).

(c) **Controls for outdoor lighting.** Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

Exception 1 to Section 130.2(c): Outdoor lighting not permitted by a health or life safety statute, ordinance or regulation to be turned OFF or reduced.

Exception 2 to Section 130.2(c): Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

1. **Daylight availability.** All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control, or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.
2. **Automatic scheduling controls.**
   A. Automatic scheduling controls shall be installed for all outdoor lighting. Automatic scheduling controls may be installed in combination with motion sensing controls or other outdoor lighting controls.
   B. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by 50 to 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.
   C. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels, and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than two hours when an override is initiated.
3. **Motion sensing controls.**
   A. Motion sensing controls shall be installed for outdoor luminaires providing lighting for general hardscape, parking lots, outdoor sales lots, vehicle service station hardscape, service station canopies, sales canopies, and non-sales canopies, where the bottom of the luminaire is mounted 24 feet above grade or lower.
   B. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by 50 to 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.
   C. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.
   D. No more than 1,500 watts of lighting power shall be controlled by a single sensor or as a single zone.

   Exception 1 to Section 130.2(c)3: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

   Exception 2 to Section 130.2(c)3: Applications listed as Exceptions to Section 140.7(a) and luminaires providing lighting for a building façade, ornamental hardscape or outdoor dining are not required to have motion sensing controls.

   Exception 3 to Section 130.2(c)3: Lighting subject to a health or life safety statute, ordinance, or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

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SECTION 130.3—SIGN LIGHTING CONTROLS

Nonresidential buildings other than healthcare facilities, and hotel/motel buildings shall comply with the applicable requirements of Sections 130.3(a)1 through 130.3(a)3.

(a) **Controls for sign lighting.** All sign lighting shall meet the requirements below as applicable:

1. **Indoor signs.** All indoor sign lighting other than exit sign lighting shall be controlled with an automatic time-switch control or astronomical time-switch control.
2. **Outdoor signs.** Outdoor sign lighting shall meet the following requirements as applicable:
   A. All outdoor sign lighting shall be controlled with a photocontrol in addition to an automatic time-switch control, or an astronomical time-switch control.

      Exception to Section 130.3(a)2A: Outdoor signs in tunnels, and signs in large permanently covered outdoor areas that are intended to be continuously lit, 24 hours per day and 365 days per year.

   B. All outdoor sign lighting that is ON both day and night shall be controlled with a dimmer that provides the ability to automatically reduce sign lighting power by a minimum of 65 percent during nighttime hours. Signs that are illuminated at night and for more than 1 hour during daylight hours shall be considered ON both day and night.

      Exception to Section 130.3(a)2B: Outdoor signs in tunnels and large covered areas that are intended to be illuminated both day and night.
3. **Demand responsive Electronic Message Center (EMC) control.** See Section 110.12 for requirements for demand responsive EMC controls.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 130.4—LIGHTING CONTROL ACCEPTANCE AND INSTALLATION CERTIFICATE REQUIREMENTS

Nonresidential buildings other than healthcare facilities and hotel/motel buildings shall comply with the applicable requirements of Sections 130.4(a) through 130.4(c). Healthcare facilities shall comply with the applicable acceptance and installation documentation requirements of OSHPD.

(a) **Lighting and receptacle control acceptance requirements.** Before an occupancy permit is granted, indoor and outdoor lighting and receptacle controls serving the building, area or site and installed to comply with Section 110.12, 120.6(h)5B, 130.1, 130.2, 130.5 or 140.6 shall be certified as meeting the Acceptance Requirements for Code Compliance as specified by the Reference Nonresidential Appendix NA7.6 and NA7.8. A Certificate of Acceptance shall be submitted to the enforcement agency under Section 10-103(a) of Part 1, that the equipment and systems meet the acceptance requirements:

1. **Reserved.**
2. **Reserved.**
3. Daylight responsive controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.1;
4. Lighting shut-OFF controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.2;
5. Demand responsive lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.3; and
6. Outdoor lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.8; and
7. Lighting systems receiving the Institutional Tuning Power Adjustment Factor shall be tested in accordance with Reference Nonresidential Appendix NA7.6.4.
8. Demand responsive controls required to control controlled receptacles shall be tested in accordance with Reference Nonresidential Appendix NA7.6.5.

(b) **Lighting control installation certificate requirements.** To be recognized for compliance with Part 6 an installation certificate shall be submitted in accordance with Section 10-103(a) for any lighting control system, energy management control system, interlocked lighting system, lighting power adjustment factor, or additional wattage available for a videoconference studio, in accordance with the following requirements, as applicable:

1. Certification that when a lighting control system is installed to comply with lighting control requirements in Part 6 it complies with the applicable requirements of Section 110.9; and complies with Reference Nonresidential Appendix NA7.7.1.
2. Certification that when an energy management control system is installed to function as a lighting control required by Part 6 it functionally meets all applicable requirements for each application for which it is installed, in accordance with Sections 110.9, 130.0 through 130.5, 140.6 through 150.0, and 150.2; and complies with Reference Nonresidential Appendix NA7.7.2.
3. **Reserved.**
4. **Reserved.**
5. Certification that interlocked lighting systems used to serve an approved area comply with Section 140.6(a)1; and comply with Reference Nonresidential Appendix NA7.7.4.
6. Certification that lighting controls installed to earn a lighting power adjustment factor (PAF) comply with Section 140.6(a)2; and comply with Reference Nonresidential Appendix NA7.7.5.

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7. Certification that additional lighting wattage installed for a videoconference studio complies with Section 140.6(c)2Gvii; and complies with Reference Nonresidential Appendix NA7.7.6.

(c) When certification is required by Title 24, Part 1, Section 10-103.1, the acceptance testing specified by Section 130.4 shall be performed by a certified lighting controls acceptance test technician (CLCATT). If the CLCATT is operating as an employee, the CLCATT shall be employed by a certified lighting controls acceptance test employer. The CLCATT shall disclose on the Certificate of Acceptance a valid CLCATT certification identification number issued by an approved acceptance test technician certification provider. The CLCATT shall complete all certificate of acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

Note: Authority cited: Sections 25402, 25402.1 and 25213, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code*.

SECTION 130.5—ELECTRICAL POWER DISTRIBUTION SYSTEMS

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 130.5(a) through 130.5(e).

(a) **Service electrical metering.** Each electrical service or feeder shall have a permanently installed metering system which measures electrical energy use in accordance with Table 130.5-A.

Exception 1 to Section 130.5(a): Service or feeder for which the utility company provides a metering system that indicates instantaneous kW demand and kWh for a utility-defined period.

Exception 2 to Section 130.5(a): Electrical power distribution systems subject to California Electrical Code Article 517.

TABLE 130.5-A—MINIMUM REQUIREMENTS FOR METERING OF ELECTRICAL LOAD

METERING FUNCTIONALITY	ELECTRICAL SERVICES RATED 50 kVA OR LESS	ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA	ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA	ELECTRICAL SERVICES RATED MORE THAN 1000 kVA
Instantaneous (at the time) kW demand	Required	Required	Required	Required
Historical peak demand (kW)	Not required	Not required	Required	Required
Tracking kWh for a user-definable period	Required	Required	Required	Required
kWh per rate period	Not required	Not required	Not required	Required

(b) **Separation of electrical circuits for electrical energy monitoring.** Electrical power distribution systems shall be designed so that measurement devices can monitor the electrical energy usage of load types according to Table 130.5-B.

Exception 1 to Section 130.5(b): For each separate load type, up to 10 percent of the connected load may be of any type.

Exception 2 to Section 130.5(b): Electrical power distribution systems subject to California Electrical Code Article 517.

TABLE 130.5-B—MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD

ELECTRICAL LOAD TYPE	ELECTRICAL SERVICES RATED 50 kVA OR LESS	ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA	ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA	ELECTRICAL SERVICES RATED MORE THAN 1000 kVA
Lighting including exit and egress lighting and exterior lighting	Not required	All lighting in aggregate	All lighting disaggregated by floor, type or area	All lighting disaggregated by floor, type or area
HVAC systems and components including chillers, fans, heaters, furnaces, package units, cooling towers and circulation pumps associated with HVAC	Not required	All HVAC in aggregate	All HVAC in aggregate and each HVAC load rated at least 50 kVA	All HVAC in aggregate and each HVAC load rated at least 50 kVA
Domestic and service water system pumps and related systems and components	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Plug load including appliances rated less than 25 kVA	Not required	All plug load in aggregate Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area All groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf

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TABLE 130.5-B—MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD—continued				
ELECTRICAL LOAD TYPE	**ELECTRICAL SERVICES RATED 50 kVA OR LESS**	**ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA**	**ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA**	**ELECTRICAL SERVICES RATED MORE THAN 1000 kVA**
Elevators, escalators, moving walks and transit systems	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Other individual non-HVAC loads or appliances rated 25 kVA or greater	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Industrial and commercial load centers 25 kVA or greater, including theatrical lighting installations and commercial kitchens	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Renewable power source (net or total)	Each group	Each group	Each group	Each group
Loads associated with renewable power source	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Charging stations for electric vehicles	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate

(c) **Voltage drop.** The maximum combined voltage drop on both installed feeder conductors and branch circuit conductors to the farthest connected load or outlet shall not exceed 5 percent.

Exception to Section 130.5(c): Voltage drop permitted by *California Electrical Code* Sections 647.4, 695.6 and 695.7.

(d) **Circuit controls for 120-volt receptacles and controlled receptacles.** In all buildings, both controlled and uncontrolled 120 volt receptacles shall be provided in office areas, lobbies, conference rooms, kitchen areas in office spaces and copy rooms. Additionally, hotel/motel guest rooms shall comply with Section 130.5(d)4.

Plug-in strips and other plug-in devices shall not be used to comply with the requirements of Section 130.5(d).

Controlled receptacles shall meet the following requirements, as applicable:

1. Install a control capable of automatically shutting OFF the controlled receptacles when the space is typically unoccupied, either at the receptacle or circuit level. When an automatic time switch control is installed it shall incorporate an override control that allows the controlled receptacle to remain ON for no more than 2 hours when an override is initiated and an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours and then resumes the normally scheduled operation. Countdown timer switches shall not be used to comply with the automatic time switch control requirements; and
2. Install at least one controlled receptacle within 6 feet from each uncontrolled receptacle or install a multiple-receptacle outlet with at least one controlled and one uncontrolled receptacle. Where receptacles are installed in modular furniture in open office areas, at least one controlled receptacle shall be installed at each workstation; and
3. Provide a permanent marking for controlled receptacles or circuits to differentiate them from uncontrolled receptacles or circuits; and
4. For hotel and motel guest rooms, install controlled receptacles for at least one-half of the 120-volt receptacles in each guestroom. Electric circuits serving controlled receptacles in guestrooms shall have captive card key controls, occupant sensing controls, or automatic controls so the power is switched OFF no longer than 20 minutes after the guestroom has been vacated.

Exception 1 to Section 130.5(d): Receptacles that are only for the following purposes:

i. Receptacles specifically for refrigerators and water dispensers in kitchen area.
ii. Receptacles located a minimum of six feet above the floor that are specifically for clocks.
iii. Receptacles for network copiers, fax machines, A/V and data equipment other than personal computers in copy rooms.
iv. Receptacles on circuits rated more than 20 amperes.
v. Receptacles connected to an uninterruptible power supply (UPS) that are intended to be in continuous use, 24 hours per day/365 days per year, and are marked to differentiate them from other uncontrolled receptacles or circuits.

Exception 2 to Section 130.5(d): Receptacles in healthcare facilities.

(e) **Demand responsive controls and equipment.** See Section 110.12 for requirements for demand responsive controls and equipment, including demand responsive controls for controlled receptacles.

Note: Definitions of terms and phrases in Section 130.5 are determined as specified in Section 100.1(b). Terms and phrases not found in Section 100.1(b) shall be defined as specified in Title 24, Part 3, Article 100 of the *California Electrical Code.*

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

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SUBCHAPTER

5

NONRESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR ACHIEVING ENERGY EFFICIENCY

SECTION 140.0—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

Nonresidential and hotel/motel buildings shall comply with all of the following:

(a) The requirements of Sections 100.0 through 110.12 applicable to the building project (mandatory measures for all buildings).

(b) The requirements of Sections 120.0 through 130.5 (mandatory measures for nonresidential and hotel/motel buildings).

(c) Either the performance compliance approach (energy budgets) specified in Section 140.1 or the prescriptive compliance approach specified in Section 140.2 for the climate zone in which the building will be located. Climate zones are shown in Figure 100.1-A.

Note to Section 140.0(c): The Commission periodically updates, publishes and makes available to interested persons and local enforcement agencies precise descriptions of the climate zones, which is available by zip code boundaries depicted in the Reference Joint Appendices along with a list of the communities in each zone.

Note to Section 140.0: The requirements of Sections 140.1 through 140.10 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 140.1 through 140.10 also apply to additions or alterations to existing buildings.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.1—PERFORMANCE APPROACH: ENERGY BUDGETS

A building complies with the performance standards if the energy consumption calculated for the proposed design building is no greater than the energy budget calculated for the standard design building using Commission-certified compliance software as specified by Sections 10-109(c) and 10-116.

(a) **Energy budget.** The energy budget is expressed in terms of long-term system cost (LSC) and source energy.

1. **Long-term system cost (LSC).** The LSC energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building and has two components, the Efficiency LSC and the Total LSC.
   A. The Efficiency LSC energy is the sum of the LSC energy for space-conditioning, water heating, mechanical ventilation, and lighting.
   B. The Total LSC energy is the sum of the Efficiency LSC energy and LSC energy from the photovoltaic system, battery energy storage systems (BESS) and demand flexibility.
2. **Source energy**. The source energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building.

Exception to Section 140.1(a). A community shared solar electric generation system, or other renewable electric generation system, and/or community shared BESS, that provides dedicated power, utility energy reduction credits or payments for energy bill reductions to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system or BESS LSC energy required to comply with the standards, as calculated according to methods established by the Commission in the Nonresidential ACM Reference Manual.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.2—PRESCRIPTIVE APPROACH

To comply using the prescriptive approach a building shall be designed with and shall have constructed and installed systems and components meeting the applicable requirements of Sections 140.3 through 140.10.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.3—PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

(a) **Envelope component requirements.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

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A. **Roofing products.** Shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i through ii:

i. Nonresidential buildings:

a. Low-sloped roofs in climate zones 1 through 16 shall have:

1. A minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75; or
2. A minimum solar reflectance index (SRI) of 75.

Exception 1 to Section 140.3(a)1Aia: Wood-framed roofs in climate zones 3 and 5 are not required to comply with Section 140.3(a)1Aia if the roof assembly has a *U*-factor of 0.034 or lower.

Exception 2 to Section 140.3(a)1Aia: Roof constructions with a weight of at least 25 lb/ft^2 over the roof membrane are not required to comply with Section 140.3(a)1Aia.

Exception 3 to Section 140.3(a)1Aia: An aged solar reflectance less than 0.63 is allowed provided the maximum roof/ceiling *U*-factor in Table 140.3 is not exceeded.

b. Steep-sloped roofs:

1. in Climate Zones 1 and 3 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.
2. in Climate Zones 2 and 4 through 16 shall have a minimum aged solar reflectance of 0.25 and a minimum thermal emittance of 0.80, or a minimum SRI of 23.

ii. Guest rooms of hotel and motel buildings:

a. Low-sloped roofs in Climate Zones 9, 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

Exception to Section 140.3(a)1Aiia: Roof constructions with a weight of at least 25 lb/ft^2 over the roof membrane.

b. Steep-sloped roofs in Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

Exception to Section 140.3(a)1A: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

B. **Roof insulation.** Roofs shall have an overall assembly *U*-factor no greater than the applicable value in Table 140.3-B, C or D, and where required by Section 110.8 and 120.7(a)3, insulation shall be placed in direct contact with a roof or drywall ceiling.

TABLE 140.3—ROOF/CEILING INSULATION TRADEOFF FOR AGED SOLAR REFLECTANCE—NONRESIDENTIAL BUILDINGS

Aged Solar Reflectance	Metal Building Climate Zone 1-16 *U*-factor	Wood Framed and Other Climate Zones 6-8 *U*-factor	Wood Framed and Other All Other Climate Zones *U*-factor
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.030
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

2. **Exterior walls.** Exterior walls shall have an overall assembly *U*-factor no greater than the applicable value in Table 140.3-B, C or D.
3. **Demising walls.** Demising walls shall meet the requirements of Section 120.7(b)7. Vertical windows in demising walls between conditioned and unconditioned spaces shall have an area-weighted average U-factor no greater than the applicable value in Table 140.3-B, C or D.
4. **Exterior floors and soffits.** Exterior floors and soffits shall have an overall assembly *U*-factor no greater than the applicable value in Table 140.3-B, C or D.
5. **Exterior Windows.** Vertical windows in exterior walls shall:

A. Percent window area shall be limited in accordance with the applicable requirements of i and ii below:

i. a west-facing area no greater than 40 percent of the gross west-facing exterior wall area, or 6 feet times the west-facing display perimeter, whichever is greater;

ii. a total area no greater than 40 percent of the gross exterior wall area, or 6 feet times the display perimeter, whichever is greater; and

Note: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area or display perimeter and windows in demising walls are not part of the window area.

Exception to Section 140.3(a)5A: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

B. Have an area-weighted average *U*-factor no greater than the applicable value in Table 140.3-B, C or D.

Exception 1 to Section 140.3(a)5B: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

Exception 2 to Section 140.3(a)5B: For vertical windows containing chromogenic type glazing:

i. The lower-rated labeled *U*-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

C. Have an area-weighted average relative solar heat gain coefficient, RSHGC, excluding the effects of interior shading, no greater than the applicable value in Table 140.3-B, C or D.

For purposes of this paragraph, the relative solar heat gain coefficient, RSHGC, of a vertical window is:

i. The solar heat gain coefficient of the windows; or

ii. Relative solar heat gain coefficient is calculated using Equation 140.3-A, if the window has an overhang or exterior horizontal slats that extend beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

Exception 1 to Section 140.3(a)5C: An area-weighted average relative solar heat gain coefficient of 0.56 or less shall be used for windows:

a. That are in the first story of exterior walls that form a display perimeter; and

b. For which codes restrict the use of overhangs to shade the windows.

Exception 2 to Section 140.3(a)5C: For vertical glazing containing chromogenic type glazing:

i. The lower-rated labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

Exception 3 to Section 140.3(a)5C: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

Note: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to SHGC requirements.

D. Have an area-weighted average visible transmittance (VT) no less than the applicable value in Tables 140.3-B and C, or Equation 140.3-B, as applicable.

Exception 1 to Section 140.3(a)5D: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 140.3(a)5D.

Exception 2 to Section 140.3(a)5D: If the window's VT is not within the scope of NFRC 200, or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

Exception 3 to Section 140.3(a)5D: For vertical windows containing chromogenic type glazing:

i. The higher-rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

Exception 4 to Section 140.3(a)5D: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

Note: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

EQUATION 140.3-A—RELATIVE SOLAR HEAT GAIN, COEFFICIENT, RSHGC

$RSHGC = SHGC \times \{1 + a \times (2.72^{-PF} - 1) \times [\sin(b \times Az) + c]\}$

where:

	a	b	c
Overhang	0.150	0.008727	5.67
Exterior Horizonal Slat	0.144	0.008727	5.13

RSHGC = Relative solar heat gain coefficient.

SHGC = Solar heat gain coefficient of the vertical fenestration.

Az = Azimuth of the vertical fenestration in degrees.

PF = Projection factor as calculated by Equation 140.3-C.

EQUATION 140.3-B—VERTICAL FENESTRATION MINIMUM VT

$VT \geq 0.11/WWR$

where:

WWR = Window wall ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in Equation 140.3-B.

VT = Visible transmittance of framed window.

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6. **Skylights.** Skylights shall:
   A. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

      Exception 1 to Section 140.3(a)6A: Buildings with atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

      Exception 2 to Section 140.3(a)6A: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

   B. Have an area-weighted performance rating *U*-factor no greater than the applicable value in Table 140.3-B, C or D.

      Exception 1 to Section 140.3(a)6B: For skylights containing chromogenic type glazing:

      i. The lower-rated labeled *U*-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and
      ii. Chromogenic glazing shall be considered separately from other glazing; and
      iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

      Exception 2 to Section 140.3(a)6B: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

   C. Have an area-weighted performance rating solar heat gain coefficient no greater than the applicable value in Table 140.3-B, C or D.

      Exception 1 to Section 140.3(a)6C: For skylights containing chromogenic type glazing:

      i. The lower-rated labeled SHGC shall be used to demonstrate compliance with this section; and
      ii. Chromogenic glazing shall be considered separately from other glazing; and
      iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

      Exception 2 to Section 140.3(a)6C: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

   D. Have an area-weighted performance rating VT no less than the applicable value in Table 140.3-B or C; and

      Exception 1 to Section 140.3(a)6D: For skylights containing chromogenic type glazing:

      i. The higher-rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity and;
      ii. Chromogenic glazing shall be considered separately from other glazing; and
      iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

      Exception 2 to Section 140.3(a)6D: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

   E. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003 or other test method approved by the Energy Commission.

      Exception 1 to Section 140.3(a)6E: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

      Exception 2 to Section 140.3(a)6E: Conditioned greenhouses. The requirements of Section 120.6(h)3 apply.

7. **Exterior doors.** All exterior doors that separate conditioned space from unconditioned space or from ambient air shall have a *U*-factor not greater than the applicable value in Table 140.3-B, C or D. Doors that are more than one-quarter glass in area are considered glazed doors.
8. **Relocatable public school buildings.** In complying with Sections 140.3(a)1 to 7 shall meet the following:
   A. Relocatable public school buildings shall comply with Table 140.3-B for a specific climate zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use only in a specific climate zone; or
   B. Relocatable public school buildings shall comply with Table 140.3-D for any climate zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use in any climate zone; and
   C. The manufacturer or builder of a relocatable public school building shall certify that components of the building comply with requirements of this section by:
      i. The placement of two (2) metal identification labels on the building, one mechanically fastened and visible from the exterior and the other mechanically fastened to the interior frame above the ceiling at the end of the module, both labels stating (in addition to any other information by the Division of the State Architect or other law) “Complies with Title 24, Part 6 for all climate zones”; and
      ii. Identification of the location of the two labels on the plans submitted to the enforcing agency.
9. **Air barrier.** To meet the requirement of Table 140.3-B, all buildings shall have a continuous air barrier that is designed and constructed to control air leakage into, and out of, the building’s conditioned space.

   Exception to Section 140.3(a)9: Relocatable public school buildings.

   A. Design. Construction documents shall include air barrier boundaries, interconnections and penetrations, and associated square foot calculations for all sides of the air barrier.
   B. Acceptable materials and assemblies. The air barrier shall be sealed at all joints for its entire length and shall be composed of:
      i. Materials that have an air permeance not exceeding 0.004 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.02 L/sec-m^2) at 75 Pa), when tested in accordance with ASTM E2178; or

Exception to Section 140.3(a)9Bi: Materials in Table 140.3-A shall be deemed to comply with Section 140.3(a)9B provided that all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions.

ii. Assemblies of materials and components that have an average air leakage not exceeding 0.04 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.2 L/m^2 at 75 Pa), when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680 or ASTM E283.

Exception to Section 140.3(a)9Bii: The following materials shall be deemed to comply with Section 140.3(a)9B if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions:

a. Concrete masonry walls that have at least two coatings of paint or at least two coatings of sealer coating.
b. Concrete masonry walls with integral rigid board insulation.
c. Structurally insulated panels.
d. Portland cement or Portland sand parge, or stucco, or a gypsum plaster, each with a minimum $^1/_2$ inch thickness.

C. Verification. Verification of the installed air barrier may be performed.

i. If verification is performed the entire building shall meet one of the following requirements:

a. An air leakage rate not exceeding 0.40 cfm/ft^2 at a pressure differential of 0.3 in. of water (1.57 psf) (2.0 L/m^2 at 75 Pa). when the entire building is tested, after completion of construction, in accordance with NA 5, or another test method approved by the Commission; or
b. For buildings that have more than 50,000 ft^2 of conditioned floor area, a sectional test method of co-pressurizing representative test floors and taking data from the specific floors to achieve the requirement in Section 140.3(a)9Ci when following the procedures in Sections NA5.2 to NA5.9. Representative test floors must meet the following conditions:

I. The entire floor area of all stories that have any spaces directly under a roof.
II. The entire floor area of all stories that have a building entrance or loading dock.
III. Representative above-grade wall sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space. Floor areas in Parts a and b above shall not be included in the 25 percent.

ii. If the air leakage requirements of either Section 140.3(a)9Cia or 140.3(a)9Cib are not met, a visual inspection and diagnostic evaluation shall be completed in accordance with NA5.7, all observed leaks shall be sealed where such sealing can be made without destruction of existing building components, and buildings where the tested leakage rate exceeded 0.6 cfm/ft^2 of building shell area at 75 Pa have been retested to confirm leakage is below 0.6 cfm/ft^2 of building shell at 75 Pa.

TABLE 140.3-A—MATERIALS DEEMED TO COMPLY WITH SECTION 140.3(a)9B

	MATERIALS	MINIMUM THICKNESS
1	Plywood	Minimum $^3/_8$ inch thickness
2	Oriented strand board	Minimum $^3/_8$ inch thickness
3	Extruded polystyrene insulation board	Minimum $^1/_2$ inch thickness
4	Foil-backed polyisocyanurate insulation board	Minimum $^1/_2$ inch thickness
5	Closed cell spray foam with a minimum density of 2.0 pcf	Minimum 2 inch thickness
6	Open cell spray foam with a density no less than 0.4 pcf and no greater than 1.5 pcf	Minimum 5$^1/_2$ inch thickness
7	Exterior and interior gypsum board	Minimum $^1/_2$ inch thickness
8	Cement board	Minimum $^1/_2$ inch thickness
9	Built-up roofing membrane	No minimum thickness
10	Modified bituminous roof membrane	No minimum thickness
11	Fully adhered single-ply roof membrane	No minimum thickness
12	A Portland cement or Portland sand parge, or a gypsum plaster	Each with minimum $^5/_8$ inch thickness
13	Cast-in-place concrete, or precast concrete	No minimum thickness
14	Fully grouted concrete block masonry	No minimum thickness
15	Sheet steel or sheet aluminum	No minimum thickness

TABLE 140.3-B—PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS (WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

ENVELOPE FEATURE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Roofs and Ceilings – Metal Building Max *U*-Factor	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Roofs and Ceilings – Wood-Framed and Other Max *U*-Factor	0.028	0.028	0.028	0.028	0.028	0.047	0.047	0.047	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Walls - Metal Building Max *U*-Factor	0.098	0.053	0.098	0.053	0.053	0.098	0.098	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.050	0.053
Walls - Metal-framed Max *U*-Factor	0.060	0.055	0.071	0.055	0.055	0.060	0.060	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Walls - Mass, Light[1] Max *U*-Factor	0.170	0.138	0.227	0.196	0.364	0.364	0.364	0.364	0.364	0.138	0.138	0.138	0.138	0.138	0.138	0.138
Walls - Mass, Heavy[1] Max *U*-Factor	0.211	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.160	0.211	0.184	0.160	0.160	0.153
Walls - Wood-framed and Other Max *U*-Factor	0.078	0.053	0.102	0.053	0.095	0.102	0.102	0.095	0.053	0.053	0.042	0.053	0.053	0.053	0.038	0.053
Floors and Soffits – Raised Mass Max *U*-Factor	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
Floors and Soffits – Other Max *U*-Factor	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
Roofing Products – Low-Sloped Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Roofing Products – Low-Sloped Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Roofing Products – Steep-Sloped Aged Solar Reflectance	0.20	0.25	0.20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Roofing Products – Steep-Sloped Thermal Emittance	0.75	0.80	0.75	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Air Barrier	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Exterior Doors – Non-Swinging Maximum *U*-Factor	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
Exterior Doors – Swinging Maximum *U*-Factor	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
FENESTRATION – VERTICAL (all climate zones) (area-weighted performance rating)																
Fixed Window (Max *U*-factor)	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.34	0.36	0.34	0.34	0.34	0.34	0.34	0.36
Fixed Window (Max RSHGC)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.22	0.25	0.22	0.22	0.22	0.22	0.22	0.25
Fixed Window (Min VT)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Curtain wall or Storefront (Max *U*-factor)	0.38	0.41	0.41	0.41	0.41	0.41	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Curtain wall or Storefront (Max RSHGC)	0.25	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Curtainwall or Storefront (Min VT)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Operable Window (Max *U*-factor)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Operable Window (Max RSHGC)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Operable Window (Min VT)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Glazed Doors (Max *U*-factor)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Glazed Doors (Max RSHGC)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Glazed Doors (Min VT)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Fenestration (Max WWR %)	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

FENESTRATION – SKYLIGHTS (all climate zones) (area-weighted performance rating)	GLASS CURB MOUNTED	GLASS DECK MOUNTED	PLASTIC CURB MOUNTED	TUBULAR DAYLIGHTING DEVICES (TDDS)
Max U-factor	0.58	0.46	0.88	0.88
Max SHGC	0.25	0.25	NR	NR
Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
Maximum SRR %	5%	5%	5%	5%

Note:

1. As defined in Section 100.1, light mass walls are walls with a heat capacity of at least 7.0 Btu/ft^2-°F and less than 15.0 Btu/ft^2-°F. Heavy mass walls are walls with a heat capacity of at least 15.0 Btu/ft^2-°F.

TABLE 140.3-C —PRESCRIPTIVE ENVELOPE CRITERIA FOR GUEST ROOMS OF HOTEL/MOTEL BUILDINGS																
ENVELOPE FEATURE	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Roofs and Ceilings – Metal Building Max U-Factor	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
Roofs and Ceilings – Wood-Framed and Other Max U-Factor	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Walls – Metal Building Max U-Factor	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
Walls – Metal-framed Max U-Factor	0.069	0.069	0.069	0.069	0.069	0.069	0.105	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.048	0.069
Walls – Mass, Light[1] Max U-Factor	0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
Walls – Mass, Heavy[1] Max U-Factor	0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
Walls – Wood-framed and Other Max U-Factor	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
Floors and Soffits – Raised Mass Max U-Factor	0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
Floors and Soffits – Other Max U-Factor	0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
Low-Sloped Roofing Products Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55	NR
Low-Sloped Roofing Products Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
Steep-Sloped Roofing Products Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
Steep-Sloped Roofing Products Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
Air Barrier	REQ	REQ	REQ	REQ	REQ	REQ	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Non-Swinging Exterior Doors Max U-Factor	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
Swinging Exterior Doors Max U-Factor	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

FENESTRATION – VERTICAL (all climate zones) (area-weighted performance rating)	**FIXED WINDOW**	**OPERABLE WINDOW**	**CURTAIN WALL AND STOREFRONT**	**GLAZED DOORS[2]**
Max U-factor	0.36	0.46	0.41	0.45
Max RSHGC	0.25	0.22	0.26	0.23
Min VT	0.42	0.32	0.46	0.17
Maximum WWR %	40%	40%	40%	40%

FENESTRATION – SKYLIGHTS (all climate zones) (area-weighted performance rating)	**GLASS CURB MOUNTED**	**GLASS DECK MOUNTED**	**PLASTIC CURB MOUNTED**
Max U-factor	0.58	0.46	0.88
Max SHGC	0.25	0.25	NR
Min VT	0.49	0.49	0.64
Maximum SRR %	5%	5%	5%

Notes:

1. As defined in Section 100.1, light mass walls are walls with a heat capacity of at least 7.0 Btu/ft^2-°F and less than 15.0 Btu/ft^2-°F. Heavy mass walls are walls with a heat capacity of at least 15.0 Btu/ft^2-°F.
2. Glazed doors applies to both site-built and to factory-assembled glazed doors.

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TABLE 140.3-D—PRESCRIPTIVE ENVELOPE CRITERIA FOR RELOCATABLE PUBLIC SCHOOL BUILDINGS FOR USE IN ALL CLIMATE ZONES		
ENVELOPE FEATURE	**CRITERIA**	**VALUE**
Roofs and Ceilings – Metal Buildings	Maximum U-factor	0.038
Roofs and Ceilings – Nonmetal Buildings	Maximum U-factor	0.028
Walls – Wood-framed buildings	Maximum U-factor	0.038
Walls – Metal-framed buildings	Maximum U-factor	0.055
Walls – Metal buildings	Maximum U-factor	0.053
Walls – Mass/7.0 ≤ HC	Maximum U-factor	0.138
Walls – All Other Walls	Maximum U-factor	0.038
Floors and Soffits – Raised Mass	Maximum U-factor	0.058
Floors and Soffits – Other	Maximum U-factor	0.039
Roofing Products – Low-Sloped	Aged Solar Reflectance	0.63
Roofing Products – Low-Sloped	Thermal Emittance	0.75
Roofing Products – Steep-Sloped	Aged Solar Reflectance	0.25
Roofing Products – Steep-Sloped	Thermal Emittance	0.80
Fenestration – Fixed Windows	Maximum U-factor	0.34
Fenestration – Fixed Windows	Maximum RSHGC	0.22
Fenestration – Fixed Windows	Minimum VT	0.42
Fenestration – Operable Windows	Maximum U-factor	0.46
Fenestration – Operable Windows	Maximum RSHGC	0.22
Fenestration – Operable Windows	Minimum VT	0.32
Fenestration – Glazed Doors (Site-Built and Factory Assembled)	Maximum U-factor	0.45
Fenestration – Glazed Doors (Site-Built and Factory Assembled)	Maximum RSHGC	0.23
Fenestration – Glazed Doors (Site-Built and Factory Assembled)	Minimum VT	0.17
Fenestration – Skylights	Maximum U-factor	See Table 140.3-B
Fenestration – Skylights	Maximum RSHGC	See Table 140.3-B
Fenestration – Skylights	Minimum VT	See Table 140.3-B
Fenestration – Skylights	Maximum SRR	5%
Exterior Doors – Non-Swinging doors	Maximum U-factor	0.50
Exterior Doors – Swinging doors	Maximum U-factor	0.70

(b) **Reserved.**

(c) **Minimum daylighting requirement for large enclosed spaces.** In climate zones 2 through 15, conditioned enclosed spaces, and unconditioned enclosed spaces that are greater than 5,000 square feet and that are directly under a roof with ceiling heights greater than 15 feet, shall meet the following requirements:

1. A combined total of at least 75 percent of the floor area, as determined in building floor plan (drawings) view, shall be within one or more of the following:
   A. Primary sidelit daylit zone in accordance with Section 130.1(d), or
   B. The total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.
2. All skylit daylit zones and primary sidelit daylit zones shall be shown on building plans.
3. General lighting in daylit zones shall be controlled in accordance with Section 130.1(d).
4. The total skylight area is at least 3 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights; or the product of the total skylight area and the average skylight visible transmittance is no less than 1.5 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.

5. All skylights shall have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D1003 (notwithstanding its scope) or other test method approved by the Commission.
6. Skylights for conditioned and unconditioned spaces shall have an area-weighted average visible transmittance (VT) no less than the applicable value required by Section 140.3(a)6D.

Exception 1 to Section 140.3(c): Auditoriums, churches, movie theaters, museums and refrigerated warehouses.

Exception 2 to Section 140.3(c): In buildings with unfinished interiors, future enclosed spaces for which there are plans to have:

A. A floor area of less than or equal to 5,000 square feet, or
B. Ceiling heights of less than or equal to 15 feet.

This exception shall not be used for S-1 or S-2 (storage), or for F-1 or F-2 (factory) occupancies.

Exception 3 to Section 140.3(c): Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 watts per square foot.

Exception 4 to Section 140.3(c): Enclosed spaces where it is documented that permanent architectural features of the building, existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

(d) Daylighting Design Power Adjustment Factors (PAFs). To qualify for a Power Adjustment Factor (PAF) as specified in Section 140.6(a)2L, daylighting devices shall meet the following requirements:

1. **Clerestory fenestration.** To qualify for a PAF, clerestory fenestration shall meet the following requirements:
   A. Shall be installed on east-, west-, or south-facing facades.
   B. Shall have a head height that is at least 10 feet above the finished floor.
   C. Shall have a glazing height that is greater than or equal to 10 percent of the head height.
   D. If operable shading is installed on the clerestory fenestration, then the clerestory fenestration shading shall be controlled separately from shading serving other vertical fenestration.
2. **Interior and exterior horizontal slats.** To qualify for a PAF, horizontal slats shall meet the following requirements:
   A. Shall be installed adjacent to vertical fenestration on east- or west-facing facades with Window Wall Ratios between 20 and 30 percent.
   B. Exterior horizontal slats shall be level or sloped downwards from fenestration. Interior horizontal slats shall be level or sloped upwards from fenestration.
   C. Shall have a projection factor as specified in Table 140.3-E. The projection factor is calculated using Equation 140.3-C.
   D. Shall have a minimum distance factor of 0.3. The distance factor is calculated using Equation 140.3-C.

      Exception to Section 140.3(d)2D: Where it is documented that existing adjacent structures or natural objects within view of the vertical fenestration block direct sunlight onto the vertical fenestration between 8 a.m. and 5 p.m. for less than 500 daytime hours per year.
   E. Shall have a minimum Visible Reflectance of 0.50 when tested as specified in ASTM E903.
   F. Shall be opaque.

      Exception to Section 140.3(d)2F: Horizontal slats with a Visible Transmittance of 0.03 or less when tested as specified in ASTM E1175.
   G. Shall be permanently mounted and not adjustable.
   H. Shall extend the entire height of the vertical fenestration and beyond each side of the window jamb by a distance equal to or greater than their horizontal projection.

      Exception to Section 140.3(d)2H: Where the slats are located entirely within the vertical fenestration's rough opening or a fin is located at the window jambs and extends vertically the entire height of the window jamb and extends horizontally the entire depth of the projection.
   I. Shall be shown on the plans with the dimensions for the slat projection and slat spacing as specified in Equation 140.3-C.
   J. Shall have a conspicuous factory installed label permanently affixed and prominently located on an attachment point of the device to the building envelope, stating the following: "NOTICE: Removal of this device will require re-submittal of compliance documentation to the enforcement agency responsible for compliance with California Title 24, Part 6".
3. **Interior and Exterior Light Shelves.** To qualify for a PAF, light shelves shall meet the following requirements:
   A. Where there is vertical fenestration area below the light shelf, both interior and exterior light shelves shall be installed.
   B. Shall be installed adjacent to clerestory fenestration on south-facing facades with Window Wall Ratios greater than 30 percent. The head height of the light shelves shall be no more than one foot below the finished ceiling. The clerestory fenestration shall meet the requirements of Section 140.3(d)1.
   C. Exterior light shelves shall be level or sloped downwards from fenestration. Interior light shelves shall be level or sloped upwards from fenestration.

D. Shall have a projection factor of the applicable value as specified in Table 140.3-E. The light shelf projection factor is calculated using Equation 140.3-C.

TABLE 140.3-E—DAYLIGHTING DEVICES

DAYLIGHTING DEVICE	ORIENTATION OF THE VERTICAL FENESTRATION	PROJECTION FACTOR
Horizontal Slats	East or West	2.0 to 3.0
Interior Light Shelf	South	1.0 to 2.0
Exterior Light Shelf	South	0.25 to 1.25

E. Shall have a minimum Distance Factor of 0.3. The distance factor is calculated using Equation 140.3-C.

Exception to Section 140.3(d)3E: Where it is documented that existing adjacent structures or natural objects within view of the vertical fenestration block direct sunlight onto the vertical fenestration between 8 a.m. and 5 p.m. for less than 750 daytime hours per year.

F. Shall have a top surface with a minimum Visible Reflectance of 0.50 when tested as specified in ASTM E903.

Exception to Section 140.3(d)3F: Where an exterior light shelf is installed greater than two feet below the clerestory sill.

G. Shall extend beyond each side of the window jamb by a distance equal to or greater than their horizontal projection.

H. Shall be shown on the plans with the dimensions for the light shelf projection and light shelf spacing as specified in Equation 140.3-C.

EQUATION 140.3-C—PROJECTION AND DISTANCE FACTOR CALCULATION

Projection Factor = Projection/Spacing

Distance Factor = $D/(H_{AS} \times$ Projection Factor)

where:

Projection = The horizontal distance between the base edge and the projected edge of the overhang, slat or light shelf.

Spacing = For overhangs, the vertical distance between the projected edge of the overhang and sill of the vertical fenestration below it.

For horizontal slats, the vertical distance between the projected edge of a slat to the base edge of the slat below it.

For interior light shelves, the vertical distance between the projected edge of the light shelf and head of the clerestory fenestration above it.

For exterior light shelves, the vertical distance between the projected edge of the light shelf and sill of the vertical fenestration below it.

D = Distance between the existing structure or nature object and the fenestration.

H_{AS} = Height difference between the top of the existing structure or nature object and the bottom of the fenestration.

Note: The base edge is the edge of an overhang, slat or light shelf that is adjacent to the vertical fenestration. The projected edge is the opposite edge from the base edge.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.4—PRESCRIPTIVE REQUIREMENTS FOR SPACE-CONDITIONING SYSTEMS

A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the applicable prescriptive requirements of Subsections (a) through (q).

(a) **Sizing, equipment selection and type.**

1. **Sizing and equipment selection.** Mechanical heating and mechanical cooling equipment serving healthcare facilities shall be sized to meet the design heating and cooling loads as calculated according to the Subsection (b). Mechanical heating and mechanical cooling equipment serving hotel/motel buildings and nonresidential buildings other than healthcare facilities shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection (b).

   Exception 1 to Section 140.4(a)1: Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building LSC.

   Exception 2 to Section 140.4(a)1: Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

   Exception 3 to Section 140.4(a)1: Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

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2. **Single zone space-conditioning system type.** Single zone space-conditioning systems with direct expansion cooling with rated cooling capacity 240,000 Btu/hr or less serving the following spaces shall meet the applicable requirements in Items A–H, or shall meet the performance compliance requirements of Section 140.1.
   A. Retail and grocery building spaces in Climate Zones 2 through 15. The space-conditioning system shall be a heat pump.
   B. Retail and grocery building spaces in Climate Zones 1 and 16 with cooling capacity less than 65,000 Btu/hr. The space-conditioning system shall be an air conditioner with furnace.
   C. Retail and grocery building spaces in Climate Zones 1 and 16 with cooling capacity 65,000 Btu/hr or greater. The space-conditioning system shall be a dual-fuel heat pump.
   D. School building spaces. For Climate Zones 2 through 15, the space-conditioning system shall be a heat pump. For Climate Zones 1 and 16, the space-conditioning system shall be a dual-fuel heat pump.
   E. Office, financial institution and library building spaces in Climate Zones 1 through 15. The space-conditioning system shall be a heat pump.
   F. Office, financial institution and library building spaces in Climate Zone 16 with cooling capacity less than 65,000 Btu/hr. The space-conditioning system shall be an air conditioner with furnace.
   G. Office, financial institution and library building spaces in Climate Zone 16 with cooling capacity 65,000 Btu/hr or greater. The space-conditioning system shall be a dual-fuel heat pump.
   H. Office spaces in warehouses. The space-conditioning system shall be a heat pump in all climate zones.
3. **Multi-zone space-conditioning system types.** Space-conditioning systems in office buildings and school buildings not covered by Section 140.4(a)2 shall meet the following requirements:

   Exception 1 to Section 140.4(a)3: Buildings greater than 150,000 square feet or greater than five (5) habitable stories.

   Exception 2 to Section 140.4(a)3: School buildings in Climate Zones 6 and 7.

   A. Space-conditioning systems shall comply with one of the following:
      i. The space-conditioning system shall be a variable refrigerant flow (VRF) heat pump system that incorporates refrigerant-loop heat recovery and with a dedicated outdoor air system (DOAS) providing ventilation to all zones served by the space-conditioning system. Indoor fans shall meet the requirements of Section 140.4(a)3D. The DOAS shall comply with Section 140.4(a)3E.
      ii. The space-conditioning system shall be four-pipe fan coil (FPFC) terminal units with a DOAS providing ventilation to all zones served by the space-conditioning system. The FPFC hot water coils shall be supplied by an air-to-water heat pump (AWHP) space-heating hot water loop that complies with Section 140.4(a)3C. Indoor fans shall meet the requirements of Section 140.4(a)3D. The DOAS shall comply with Section 140.4(a)3E.
      iii. For office buildings in all climate zones and school buildings in Climate Zones 2, 4 and 8 through 16, the space-conditioning system shall be a variable air volume (VAV) system that utilizes heating supplied through a hot water loop served by an AWHP that complies with Section 140.4(a)3C and the following:
         a. For office buildings:
            I. The portion of perimeter zone terminal unit heating capacity utilizing parallel fan-powered boxes complying with Section 140.4(a)3E shall be:
               1) One hundred percent in Climate Zones 1 through 6 and 16.
               2) Twenty-five percent in Climate Zones 7 through 15.
            II. Ventilation systems in Climate Zones 1, 3, and 5 shall be equipped with a heat recovery system in compliance with Section 140.4(q).
            III. The maximum allowed fan power in Climate Zones 3 and 5 shall be 15 percent lower than specified by Section 140.4(c)1.
         b. For school buildings:
            I. All perimeter zone terminal units shall be parallel fan-powered boxes complying with Section 140.4(a)3E.
            II. Ventilation systems in Climate Zones 2, 4, and 11 through 16 shall be equipped with a heat recovery system in compliance with Section 140.4(q).
            III. The maximum allowed fan power in Climate Zone 2 shall be 15 percent lower than specified by Section 140.4(c)1.
            IV. The design leaving water temperature of the heating loop shall be no greater than 120°F in Climate Zone 2.
      iv. The space-conditioning system shall be a dual fan, dual duct (DFDD) system with hot and cold decks each served by separate fan systems, and:
         a. When required by Section 140.4(e), economizers shall be located on the cold deck,
         b. The hot deck shall supply 100 percent return air, except outdoor air may be supplied as required to supplement the cold deck to maintain the design minimum outdoor air rate,
         c. The hot deck heating source shall be a heat pump, and

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d. The DFDD and DFDD terminal unit control sequence shall comply with ASHRAE Guideline 36.

v. A space-conditioning system determined by the Executive Director to use no more energy than the systems specified in Section 140.4(a)3.

B. Reserved.

C. **AWHP space-heating hot water loop.** AWHPs used to comply with the requirements of Section 140.4(a)3Aii, 140.4(a)3Aiii, or 140.4(a)3B, when used for space-heating hot water shall meet the following requirements:

i. The minimum efficiency requirements specified in Table 110.2-J, and

ii. If chilled water produced by an AWHP is used for space cooling, then the heat recovery system shall comply with Section 140.4(s), and

iii. Supplemental heating shall be provided by an electric resistance boiler with a capacity of not greater than 50 percent of the design space-heating hot water loop heating capacity.

D. **Indoor fans.** Indoor fans used to comply with the requirements of Section 140.4(a)3Ai or 140.4(a)3Aii shall have a maximum fan power of 0.35 W/cfm at design airflow, shall have not less than three speeds and shall turn off when there is no demand for heating or cooling in the space. At 66 percent airflow the power draw shall be no more than 51 percent of the fan power at full fan speed, and at 33 percent airflow the power draw shall be no more than 12 percent of the fan power at full fan speed.

E. **DOAS.** DOAS used to comply with the requirements of Section 140.4(a)3Ai or 140.4(a)3Aii shall comply with Section 140.4(p), be equipped with a heat recovery system in compliance with Section 140.4(q) and have a maximum fan power of 0.77 W/cfm at design airflow. DOAS units that provide active heating or cooling shall meet one of the following requirements:

i. For hydronic heating or cooling:

a. DOAS heating coils shall be hydronic heating coils utilizing the AWHP space-heating hot water loop.

b. DOAS cooling coils shall be hydronic cooling coils utilizing space-cooling chilled water loop.

ii. Other heating or cooling shall be provided by a heat pump. Electric resistance heating shall not be used.

F. Parallel fan-powered boxes used to comply with Section 140.4(a)3Aiii shall use recirculated zone or plenum air shall be used in heating mode. Fans shall cycle on only when there is a demand for heating and shall have a maximum fan power of 0.3 W/cfm at design airflow. Terminal units providing ventilation air shall be set to no greater than the minimum ventilation rate when the zone is in deadband or in heating mode.

(b) **Calculations.** In making equipment sizing calculations under Subsection (a), all of the following rules shall apply:

1. **Heating and cooling loads.** Heating and cooling system design loads shall be determined in accordance with the procedures described in Subsection A or B below:

A. For systems serving hotel/motel buildings, and nonresidential buildings other than healthcare facilities, the method in the 2017 ASHRAE Handbook, Fundamentals shall be used or as specified in a method approved by the Commission.

B. For system serving healthcare facilities the method in the *California Mechanical Code* shall be used.

2. **Indoor design conditions.** Indoor design temperature and humidity conditions for comfort applications shall be determined in accordance with Subsection A or B below:

A. For systems serving hotel/motel buildings, and nonresidential buildings other than healthcare facilities, ASHRAE Standard 55 or the 2017 ASHRAE Handbook, Fundamentals Volume, except that winter humidification and summer dehumidification shall not be required.

B. For systems serving healthcare facilities the method in the *California Mechanical Code* shall be used.

3. **Outdoor design conditions.** Outdoor design conditions shall be selected in accordance with Subsection A or B below:

A. For systems serving hotel/motel buildings and nonresidential buildings other than healthcare facilities the design conditions shall meet the following:

i. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X or the ASHRAE Handbook, Fundamentals Volume.

ii. Heating design temperatures shall be no lower than the 99.0 percent Heating Dry Bulb or the Heating Winter Median of Extremes values.

iii. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

B. For system serving healthcare facilities the method in Section 320.0 of the *California Mechanical Code* shall be used.

Exception to Section 140.4(b)3: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent cooling design wet bulb values.

4. **Ventilation.** Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 120.1(c)3.

5. **Envelope.** Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, Solar Heat Gain Coefficient or shading coefficient, and air leakage, consistent with the proposed design.

6. **Lighting.** Lighting heating and cooling loads shall be based on actual design lighting levels or power densities as specified in Section 140.6.

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7. **People.** Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 120.1(c)3A, if used. Sensible and latent heat gains shall be as listed in the 2017 ASHRAE Handbook, Fundamentals, Chapter 18.
8. **Process loads.** Loads caused by a process shall be based upon actual information on the intended use of the building.
9. **Miscellaneous equipment.** Equipment loads other than process loads shall be calculated using design data compiled from one or more of the following sources:
   A. Actual information based on the intended use of the building; or
   B. Published data from manufacturer's technical publications or from technical societies, such as the ASHRAE Handbook, Applications Volume; or
   C. Other data based on the designer's experience of expected loads and occupancy patterns.
10. **Internal heat gains.** Internal heat gains may be ignored for heating load calculations.
11. **Safety factor.** Calculated design loads based on 140.4(b)1 through 10 may be increased by up to 10 percent to account for unexpected loads or changes in space usage.
12. **Other loads.** Loads such as warm-up or cool-down shall be calculated from principles based on the thermal capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. In addition, the steady-state load may include a safety factor in accordance with Section 140.4(b)11.

(c) **Fan systems.** Each fan system moving air into, out of or between conditioned spaces or circulating air for the purpose of conditioning air within a space shall meet the requirements of Items 1, 2 and 3 below.

1. **Fan power budget.** For each fan system that includes at least one fan or fan array with fan electrical input power ≥ 1 kW, fan system electrical input power (Fan $kW_{design,system}$) determined per Section 140.4(c)1(B) at the fan system design airflow shall not exceed Fan kW_{budget} as calculated per Section 140.4(c)1(A).
   A. **Calculation of fan power budget (Fan kW_{budget}).** For each fan system:
      i. Determine the fan system airflow and choose the appropriate table(s) for fan power allowance.
         a. For single-cabinet fan systems, use the fan system airflow and the power allowances in both Table 140.4-A and Table 140.4-B.
         b. For supply-only fan systems, use the fan system airflow and power allowances in Table 140.4-A.
         c. For relief fan systems, use the design relief airflow and the power allowances in Table 140.4-B.
         d. For exhaust, return and transfer fan systems, use the fan system airflow and the power allowances in Table 140.4-B.
         e. For complex fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the fan system design conditions, and the power allowances in Table 140.4-A. For the return exhaust airflow, use return/exhaust airflow at the fan system design conditions, and the power allowances in Table 140.4-B.
      ii. For each fan system determine the components included in the fan system and sum the fan power allowances of those components. All fan systems shall include the system base allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the fan power allowance for that component per Equation 140.4-A:

      EQUATION 140.4-A FAN POWER ALLOWANCE

      $$FPA_{adj} = \frac{Q_{comp}}{Q_{sys}} \times FPA_{comp}$$

      where:

      FPA_{adj} = The corrected fan power allowance for the component in W/cfm.

      Q_{comp} = The airflow through component in cfm.

      Q_{sys} = The fan system airflow in cfm.

      FPA_{comp} = The fan power allowance of the component from Table 140.4A or Table 140.4B.

      iii. Multiply the fan system airflow by the sum of the fan power allowances for the fan system.
      iv. Divide by 1000 to convert to Fan kW_{budget}.
      v. For building sites at elevations greater than 3,000 feet, multiply Fan kW_{budget} by the correction factor in Table 140.4-C.

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TABLE 140.4-A—SUPPLY FAN POWER ALLOWANCES (watts/cfm)

AIRFLOW	MULTI-ZONE VAV SYSTEMS ≤ 5,000 cfm[1]	MULTI-ZONE VAV SYSTEMS > 5,000 and ≤ 10,000 cfm[1]	MULTI-ZONE VAV SYSTEMS > 10,000 cfm[1]	ALL OTHER FAN SYSTEMS ≤ 5,000 cfm	ALL OTHER FAN SYSTEMS > 5,000 and ≤ 10,000 cfm	ALL OTHER FAN SYSTEMS > 10,000 cfm[1]
Supply system base allowance for AHU serving spaces ≤ 6 floors away)	0.395	0.453	0.413	0.232	0.256	0.236
Supply system base allowance for AHU serving spaces > 6 floors away	0.508	0.548	0.501	0.349	0.356	0.325
MERV 13 to MERV 16 filter upstream of thermal conditioning equipment (two times the clean filter pressure drop)[2]	0.136	0.114	0.105	0.139	0.120	0.107
MERV 13 to MERV 16 final filter downstream of thermal conditioning equipment (two times the clean filter pressure drop)[2]	0.225	0.188	0.176	0.231	0.197	0.177
Filtration allowance for > MERV 16 or HEPA filter (two times the clean filter pressure drop)[2]	0.335	0.280	0.265	0.342	0.292	0.264
Central hydronic heating coil allowance	0.046	0.048	0.052	0.046	0.050	0.054
Electric heat allowance	0.046	0.038	0.035	0.046	0.040	0.036
Gas heat allowance	0.069	0.057	0.070	0.058	0.060	0.072
Hydronic/DX cooling coil or heat pump coil (wet) allowance[3]	0.135	0.114	0.105	0.139	0.120	0.107
Solid or liquid desiccant system allowance	0.157	0.132	0.123	0.163	0.139	0.124
Reheat coil for dehumidification allowance	0.045	0.038	0.035	0.046	0.040	0.036
Allowance for evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed watts/cfm per 1.0 inch of water gauge (in. w.g.) Determine pressure loss (in. w.g.) at 400 fpm or maximum velocity allowed by the manufacturer, whichever is less. *[Calculation required, see Note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Allowance for 100% outdoor air system[5]	0.000	0.000	0.000	0.070	0.100	0.107
Energy recovery allowance for 0.50 ≤ ERR < 0.55[6]	0.135	0.114	0.105	0.139	0.120	0.107
Energy recovery allowance for 0.55 ≤ ERR < 0.60[6]	0.160	0.134	0.124	0.165	0.141	0.126
Energy recovery allowance for 0.60 ≤ ERR < 0.65[6]	0.184	0.155	0.144	0.190	0.163	0.146
Energy recovery allowance for 0.65 ≤ ERR < 0.70[6]	0.208	0.175	0.163	0.215	0.184	0.165
Energy recovery allowance for 0.70 ≤ ERR < 0.75[6]	0.232	0.196	0.183	0.240	0.205	0.184
Energy recovery allowance for 0.75 ≤ ERR < 0.80[6]	0.257	0.216	0.202	0.264	0.226	0.203
Energy recovery allowance for ERR ≥ 0.80[6]	0.281	0.236	0.222	0.289	0.247	0.222
Coil runaround loop	0.135	0.114	0.105	0.139	0.120	0.107
Allowance for gas phase filtration. Value shown is allowed w/cfm per 1.0 in. w.g. air pressure drop. *[Calculation required, see Note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Economizer return damper	0.045	0.038	0.035	0.046	0.040	0.036
Air blender allowance	0.045	0.038	0.035	0.046	0.040	0.036
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.034	0.029	0.026	0.035	0.030	0.027
Deduction for systems that feed a terminal unit with a fan with electrical input power < 1 kW	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100
Low-turndown single-zone VAV fan systems meeting the requirements in Note 7.	0.000	0.000	0.000	0.070	0.100	0.089

1. See Section 100.1 for the definition of FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV).
2. Filter fan power allowance can only be counted once per fan system, except fan systems in healthcare facilities, which can claim one of the MERV 13 to 16 filter allowances and the HEPA filter allowance if both are included in the fan system.
3. Healthcare facilities can claim this fan power allowance twice per fan system where coil design leaving air temperature is less than 44°F.
4. Power allowance requires further calculation by multiplying the actual inches of water gauge (in. w.g.) of the device/component by the watts/cfm in Table 140.4-A.
5. The 100% outdoor air system must serve three or more HVAC zones and airflow during noneconomizer operating periods must not exceed 135% of minimum requirements in Section 120.1(c)(3).
6. Enthalpy recovery ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
7. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.

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TABLE 140.4-B—EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (WATTS/CFM)						
AIRFLOW	**MULTI-ZONE VAV SYSTEMS[1] ≤ 5,000 cfm**	**MULTI-ZONE VAV SYSTEMS[1] > 5,000 and ≤ 10,000 cfm**	**MULTI-ZONE VAV SYSTEMS[1] > 10,000 cfm**	**ALL OTHER FAN SYSTEMS ≤ 5,000 cfm**	**ALL OTHER FAN SYSTEMS > 5,000 and ≤ 10,000 cfm**	**ALL OTHER FAN SYSTEMS > 10,000 cfm**
Exhaust system base allowance	0.221	0.246	0.236	0.186	0.184	0.190
Filter (any MERV value)[2]	0.046	0.041	0.036	0.046	0.041	0.035
Energy recovery allowance for 0.50 ≤ ERR < 0.55[3]	0.139	0.120	0.107	0.139	0.123	0.109
Energy recovery allowance for 0.55 ≤ ERR < 0.60[3]	0.165	0.142	0.126	0.165	0.144	0.128
Energy recovery allowance for 0.60 ≤ ERR < 0.65[3]	0.190	0.163	0.146	0.191	0.166	0.148
Energy recovery allowance for 0.65 ≤ ERR < 0.70[3]	0.215	0.184	0.165	0.216	0.188	0.167
Energy recovery allowance for 0.70 ≤ ERR < 0.75[3]	0.240	0.206	0.184	0.241	0.209	0.186
Energy recovery allowance for 0.75 ≤ ERR < 0.80[3]	0.265	0.227	0.203	0.266	0.231	0.205
Energy recovery allowance for ERR ≥ 0.80[3]	0.289	0.248	0.222	0.291	0.252	0.225
Coil runaround loop	0.139	0.120	0.107	0.139	0.123	0.109
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.116	0.100	0.089	0.116	0.102	0.091
Return and/or exhaust airflow control devices required for space pressurization control	0.116	0.100	0.089	0.116	0.102	0.091
Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 ft. Value shown is allowed W/cfm per 0.25 in. w.g. for each 100 ft exceeding 75 ft. *[Calculation required, see Note 4]*	0.058	0.051	0.045	0.058	0.052	0.046
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 in. w.g. air pressure drop. *[Calculation required, see Note 4]*	0.231	0.198	0.177	0.232	0.202	0.179
Exhaust filters, scrubbers or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 in. w.g. air pressure drop. *[Calculation required, see Note 4]*	0.231	0.198	0.177	0.232	0.202	0.179
Healthcare facility allowance[5]	0.231	0.198	0.177	0.232	0.202	0.179
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.035	0.030	0.027	0.035	0.031	0.028

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) in definitions for "Multi-zone" to be classified as a multi-zone VAV system.
2. Filter pressure loss can only be counted once per fan system.
3. Enthalpy recovery ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
4. Power allowance requires further calculation, multiplying the actual pressure drop (in. w.g.) of the device/component by the watts/cfm in Table 140.4-B.
5. This allowance can only be taken for healthcare facilities.

TABLE 140.4-C—AIR DENSITY CORRECTION FACTORS	
ALTITUDE (ft)	**CORRECTION FACTOR**
< 3,000	1.000
≥ 3,000 and < 4,000	0.896
≥ 4,000 and < 5,000	0.864
≥ 5,000 and < 6,000	0.832
≥ 6,000	0.801

B. Determining fan system electrical input power (Fan $kW_{design,system}$). Fan $kW_{design,system}$ is the sum of Fan kW_{design} for each fan or fan array included in the fan system with Fan kWdesign ≥ 1 kW. If variable speed drives are used, their efficiency losses shall be included. Fan input power shall be calculated with two times the clean filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The Fan kW_{design} for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:

i. Use the default Fan kW_{design} in Table 140.4-D for one or more of the fans. This method cannot be used for complex fan systems.

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ii. Use the Fan kW_{design} at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in USDOE 10 CFR Part 430, USDOE 10 CFR Part 431, ANSI/AMCA Standard 208-2018, ANSI/AMCA Standard 210-2016, AHRI Standard 430-2020, AHRI Standard 440-2019 or ISO 5801-2017.

iii. Use the Fan kW_{design} provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in Section 5.3 of ANSI/AMCA 208-2018.

iv. Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate.

TABLE 140.4-*D*—DEFAULT VALUES FOR FAN KW_{DESIGN} BASED ON MOTOR NAMEPLATE HP

MOTOR NAMEPLATE HP	DEFAULT FAN KW_{design} WITH VARIABLE SPEED DRIVE (Fan kW_{design})	DEFAULT FAN KW_{design} WITHOUT VARIABLE SPEED DRIVE (Fan kW_{design})
< 1	0.96	0.89
≥ 1 and < 1.5	1.38	1.29
≥ 1.5 and < 2	1.84	1.72
≥ 2 and < 3	2.73	2.57
≥ 3 and < 5	4.38	4.17
≥ 5 and < 7.5	6.43	6.15
≥ 7.5 and < 10	8.46	8.13
≥ 10 and < 15	12.47	12.03
≥ 15 and < 20	16.55	16.04
≥ 20 and < 25	20.58	19.92
≥ 25 and < 30	24.59	23.77
≥ 30 and < 40	32.74	31.70
≥ 40 and < 50	40.71	39.46
≥ 50 and < 60	48.50	47.10
≥ 60 and < 75	60.45	58.87
≥ 75 and ≤ 100	80.40	78.17

1. This table cannot be used for motor nameplate horsepower values greater than 100.
2. This table is to be used only with motors with a service factor ≤ 1.15. If the service factor is not provided, this table may not be used.

2. **Variable air volume (VAV) systems.**

A. Static pressure sensor location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller setpoint is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section 140.4(c)2B. If this results in the sensor being located downstream of any major duct split, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint; and

B. Setpoint reset. For systems with direct digital control of individual zone boxes reporting to the central control panel:

i. Static pressure setpoints shall be reset based on the zone requiring the most pressure.

ii. Control sequences of operation for static pressure setpoint reset shall be in accordance with ASHRAE Guideline 36.

3. **Fractional HVAC motors for fans.** HVAC motors for fans that are less than 1 hp and $^1/_{12}$ hp or greater shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

Exception 1 to Section 140.4(c)3: Motors in fan-coils and terminal units that operate only when providing heating to the space served.

Exception 2 to Section 140.4(c)3: Motors in space conditioning equipment certified under Section 110.1 or 110.2.

Exception to Section 140.4(c): Fan system power caused solely by process loads.

(d) **Space-conditioning zone controls.** Each space-conditioning zone shall have controls designed in accordance with 1 or 2:

1. Each space-conditioning zone shall have controls that prevent:

A. Reheating; and

B. Recooling; and

C. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems; or

2. Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or mixed air are allowed only if the controls meet all of the following requirements:
   A. For each zone with direct digital controls (DDC):
      i. The volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of:
         a. 50 percent of the peak primary airflow; or
         b. The design zone outdoor airflow rate as specified by Section 120.1(c)3.
      ii. The volume of primary air in the deadband shall not exceed the design zone outdoor airflow rate as specified by Section 120.1(c)3.
      iii. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint no higher than 95°F while the airflow is maintained at the dead band flow rate.
      iv. The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.
      v. Control sequences of operation for reheat zones shall be in accordance with ASHRAE Guideline 36.
   B. For each zone without DDC, the volume of primary air that is reheated, re-cooled, or mixed air supply shall not exceed the larger of the following:
      i. 30 percent of the peak primary airflow; or
      ii. The design zone outdoor airflow rate as specified by Section 120.1(c)3.

Exception 1 to Section 140.4(d): Zones with special pressurization relationships or cross-contamination control needs.

Exception 2 to Section 140.4(d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

Exception 3 to Section 140.4(d): Zones in which specific humidity levels are required to satisfy non-covered process loads. Computer rooms or other spaces where the only process load is from IT equipment may not use this exception.

Exception 4 to Section 140.4(d): Zones with a peak supply-air quantity of 300 cfm or less.

Exception 5 to Section 140.4(d): Systems serving healthcare facilities.

(e) **Economizers.**

1. Each cooling air handler that has a design total mechanical cooling capacity over 33,000 Btu/hr or chilled-water cooling systems without a fan or that use induced airflow that has a cooling capacity greater than the systems listed in Table 140.4-C, shall include either:
   A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside air; or
   B. A water economizer capable of providing 100 percent of the expected system cooling load at outside air temperatures of 50°F dry-bulb and 45°F wet-bulb and below.

   Exception 1 to Section 140.4(e)1: Where special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

   Exception 2 to Section 140.4(e)1: Where the use of outdoor air for cooling will affect other systems, such as humidification, dehumidification or supermarket refrigeration systems, so as to increase overall building LSC.

   Exception 3 to Section 140.4(e)1: Systems serving hotel/motel guestrooms.

   Exception 4 to Section 140.4(e)1: Where comfort cooling systems have the cooling efficiency that meets or exceeds the cooling efficiency improvement requirements in Table 140.4-F.

   Exception 5 to Section 140.4(e)1: Fan systems primarily serving computer rooms. See Section 140.9(a) for computer room economizer requirements.

   Exception 6 to Section 140.4(e)1: In all climate zones, each air handler that has a design total mechanical cooling capacity less than 54,000 Btu/hr where ventilation is provided by a dedicated outdoor air system (DOAS) with exhaust air heat recovery in accordance with Section 140.4(p) and the following:
      A. The DOAS unit shall meet the exhaust air heat recovery ratio as specified in Section 140.4(q)1 and include bypass or control to disable energy recovery as specified in Section 140.4(q)2.
      B. The DOAS unit shall provide at least the minimum ventilation air flow rate as specified in Section 120.1(c)3 and provide no less than 0.3 cfm/ft^2 during economizer conditions.

   Exception 7 to Section 140.4(e)1: Where the use of an air economizer in controlled environment horticulture spaces will affect carbon dioxide enrichment systems.

   Exception 8 to Section 140.4(e)1: Systems complying with Sections 140.4(a)3Ai and 140.4(a)3Aii.

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TABLE 140.4-E—CHILLED WATER SYSTEM COOLING CAPACITY		
CLIMATE ZONES	TOTAL BUILDING CHILLED WATER SYSTEM CAPACITY, MINUS CAPACITY OF THE COOLING UNITS WITH AIR ECONOMIZERS	
	Building Water-Cooled Chilled Water System	Air-Cooled Chilled Water Systems or District Chilled Water Systems
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1–14	≥ 720,000 Btu/h (210 kW)	≥ 940,000 Btu/h (275 kW)
16	≥ 1,320,000 Btu/h (385 kW)	≥ 1,720,000 Btu/h (505 kW)

TABLE 140.4-F—ECONOMIZER TRADE-OFF TABLE FOR COOLING SYSTEMS	
CLIMATE ZONE	EFFICIENCY IMPROVEMENT[a]
1	70%
2	65%
3	65%
4	65%
5	70%
6	30%
7	30%
8	30%
9	30%
10	30%
11	30%
12	30%
13	30%
14	30%
15	30%
16	70%

a. If a unit is rated with an annualized or part-load metric, then to eliminate the required economizer, only the applicable minimum cooling efficiency of the unit must be increased by the percentage shown. If the unit is only rated with a full load metric, like EER or COP cooling, then that metric must be increased by the percentage shown. To determine the efficiency required to eliminate the economizer, when the unit equipment efficiency is rated with an energy-input divided by work-output metric, the metric shall first be converted to COP prior to multiplying by the efficiency improvement percentage and then converted back to the rated metric.

2. If an economizer is required by Section 140.4(e)1, and an air economizer is used to meet the requirement, then it shall be:
   A. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

      Exception to Section 140.4(e)2A: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

   B. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.
   C. Designed and equipped with a device type and high limit shut off complying with Table 140.4-G.

TABLE 140.4-G—AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS			
DEVICE TYPE[a]	CLIMATE ZONES	REQUIRED HIGH LIMIT (ECONOMIZER OFF WHEN):	
		Equation[b]	Description
Fixed dry bulb	1, 3, 5, 11–16	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
	2, 4, 10	T_{OA} > 73°F	Outdoor air temperature exceeds 73°F
	6, 8, 9	T_{OA} > 71°F	Outdoor air temperature exceeds 71°F
	7	T_{OA} > 69°F	Outdoor air temperature exceeds 69°F
Differential dry bulb	1, 3, 5, 11–16	T_{OA} > T_{RA}°F	Outdoor air temperature exceeds return air temperature
	2, 4, 10	T_{OA} > T_{RA}-2°F	Outdoor air temperature exceeds return air temperature minus 2°F
	6, 8, 9	T_{OA} > T_{RA}-4°F	Outdoor air temperature exceeds return air temperature minus 4°F
	7	T_{OA} > T_{RA}-6°F	Outdoor air temperature exceeds return air temperature minus 6°F
Fixed Enthalpy[c] + Fixed dry bulb	All	h_{OA} > 28 Btu/lb[c] or T_{OA} > 75°F	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[c] or Outdoor air temperature exceeds 75°F

a. Only the high limit control devices listed are allowed to be used and at the setpoints listed. Others such as Dew Point, Fixed Enthalpy, Electronic Enthalpy, and Differential Enthalpy Controls may not be used in any climate zone for compliance with Section 140.4(e)1 unless approval for use is provided by the Energy Commission Executive Director.
b. Devices with selectable (rather than adjustable) setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.
c. At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6,000 foot elevation, the fixed enthalpy limit is approximately 30.7 Btu/lb.

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D. If controlled by a DDC system, configured with control sequences of operation in accordance with ASHRAE Guideline 36.

E. The air economizer and all air dampers shall have the following features:

i. **Warranty.** 5-year manufacturer warranty of economizer assembly.

ii. **Damper reliability testing.** Suppliers of economizers shall certify that the economizer assembly, including but not limited to outdoor air damper, return air damper, drive linkage and actuator, have been tested and are able to open and close against the rated airflow and pressure of the system for 60,000 damper opening and closing cycles.

iii. **Damper leakage.** Economizer outdoor air and return air dampers shall have a maximum leakage rate of 10 cfm/sf at 250 Pascals (1.0 in. of water) when tested in accordance with AMCA Standard 500-D. The economizer outside air and return air damper leakage rates shall be certified to the Energy Commission in accordance with Section 110.0.

iv. **Adjustable setpoint.** If the high-limit control is fixed dry bulb or fixed enthalpy + fixed dry bulb, then the control shall have an adjustable setpoint.

v. **Sensor accuracy.** Outdoor air, return air, mixed air, and supply air sensors shall be calibrated within the following accuracies.

1. Drybulb and wetbulb temperatures accurate to ±2°F over the range of 40°F to 80°F;
2. Enthalpy accurate to ±3 Btu/lb over the range of 20 Btu/lb to 36 Btu/lb;
3. Relative humidity (RH) accurate to ±5 percent over the range of 20 percent to 80 percent RH;

vi. **Sensor calibration data.** Data used for control of the economizer shall be plotted on a sensor performance curve.

vii. **Sensor high limit control.** Sensors used for the high limit control shall be located to prevent false readings, including but not limited to being properly shielded from direct sunlight.

viii. **Relief air system.** Relief air systems shall be capable of providing 100 percent outside air without over-pressurizing the building.

F. The space-conditioning system shall include the following:

i. Unit controls shall have mechanical capacity controls interlocked with economizer controls such that the economizer is at 100 percent open position when mechanical cooling is on and does not begin to close until the leaving air temperature is less than 45°F.

ii. Direct Expansion (DX) units greater than 65,000 Btu/hr that control the capacity of the mechanical cooling directly based on occupied space temperature shall have a minimum of two stages of mechanical cooling capacity.

iii. DX units not within the scope of Section 140.4(e)2Fii shall comply with the requirements in Table 140.4-H, and have controls that do not false load the mechanical cooling system by limiting or disabling the economizer or by any other means except at the lowest stage of mechanical cooling capacity.

TABLE 140.4-H—DIRECT EXPANSION (DX) UNIT REQUIREMENTS FOR COOLING STAGES AND COMPRESSOR DISPLACEMENT

COOLING CAPACITY	MINIMUM NUMBER OF MECHANICAL COOLING STAGES	MINIMUM COMPRESSOR DISPLACEMENT
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

3. Systems that include a water economizer to meet Section 140.4(e)1 shall include the following:

A. Maximum pressure drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer shall either have a waterside pressure drop of less than 15 feet of water, or a secondary loop shall be installed so that the coil or heat exchanger pressure drop is not contributing to pressure drop when the system is in the normal cooling (non-economizer) mode.

B. Economizer systems shall be integrated with the mechanical cooling system so that they are capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling system by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

(f) **Supply air temperature reset controls.** Space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply air temperatures. Air distribution systems serving zones that are likely to have constant loads shall be designed for the air flows resulting from the fully reset supply air temperature. Supply air temperature reset controls shall be:

1. In response to representative building loads or to outdoor air temperature; and

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2. At least 25 percent of the difference between the design supply-air temperature and the design room air temperature.
3. Configured with control sequences of operation in accordance with ASHRAE Guideline 36.

Exception 1 to Section 140.4(f): Systems that meet the requirements of Section 140.4(d)1, without using Exception 1 to that section.

Exception 2 to Section 140.4(f): Where supply-air temperature reset would increase overall building energy use.

Exception 3 to Section 140.4(f): Systems supplying zones in which specific humidity levels are required to satisfy process loads. Computer rooms or other spaces with only IT equipment may not use this exception.

Exception 4 to Section 140.4(f): Systems serving healthcare facilities.

(g) **Electric resistance heating.** Electric resistance heating systems shall not be used for space heating.

Exception 1 to Section 140.4(g): Where an electric resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

Exception 2 to Section 140.4(g): Where an electric resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 140.4(a) at the design outdoor temperature specified in Section 140.4(b)4.

Exception 3 to Section 140.4(g): Where the total capacity of all electric resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

Exception 4 to Section 140.4(g): Where the total capacity of all electric resistance heating systems serving the entire building, excluding those allowed under Exception 2, is no more than 3 kW.

Exception 5 to Section 140.4(g): Where an electric resistance heating system serves an entire building that is not a hotel/motel building; and has a conditioned floor area no greater than 5,000 square feet; and has no mechanical cooling; and is in an area where natural gas is not currently available.

Exception 6 to Section 140.4(g): Heating systems serving as emergency backup to gas heating equipment.

Exception 7 to Section 140.4(g): Supplemental electric resistance heating systems complying with Section 140.4(a)3C.

(h) **Heat rejection systems.** Heat rejection equipment used in comfort cooling systems, such as air-cooled condensers, open cooling towers, closed-circuit cooling towers and evaporative condensers shall include the following:

1. **Fan speed control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at two thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature or pressure of the heat rejection device.

   Exception 1 to Section 140.4(h)1: Heat rejection devices included as an integral part of the equipment listed in Tables 110.2-A through 110.2-N.

   Exception 2 to Section 140.4(h)1: Condenser fans serving multiple refrigerant circuits.

   Exception 3 to Section 140.4(h)1: Condenser fans serving flooded condensers.

   Exception 4 to Section 140.4(h)1: Up to one third of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.
2. **Tower flow turndown.** Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:
   A. The flow that is produced by the smallest pump, or
   B. 50 percent of the design flow for the cell.
3. **Limitation on centrifugal fan cooling towers.** Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall use propeller fans and shall not use centrifugal fans.

   Exception 1 to Section 140.4(h)3: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

   Exception 2 to Section 140.4(h)3: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 110.2, Table 110.2-F.
4. **Multiple cell heat rejection equipment.** Multiple cell heat rejection equipment with variable speed fan drives shall:
   A. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components, and
   B. Control all operating fans to the same speed. Minimum fan speed shall comply with the minimum allowable speed of the fan drive as specified by the manufacturer's recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.
5. **Cooling tower efficiency.** Axial fan, open-circuit cooling towers serving condenser water loops for chilled water plants with a total of 900 gpm or greater, shall have a minimum rated efficiency based on Table 140.4-H-2 when rated in accordance with the conditions as listed in Table 110.2-F.

   Exception to Section 140.4(h)5: Replacement of existing cooling towers that are inside an existing building or on an existing roof.

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TABLE 140.4-H-2—MINIMUM EFFICIENCY FOR PROPELLER OR AXIAL FAN OPEN-CIRCUIT COOLING TOWERS (GPM/HP)															
CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
42.1	70	60	70	70	80	80	80	80	80	60	70	80	60	80	42.1

(i) **Minimum chiller efficiency.** Chillers shall meet or exceed Path B from Table 110.2-D.

Exception 1 to Section 140.4(i): Chillers with electrical service > 600V.

Exception 2 to Section 140.4(i): Chillers attached to a heat recovery system with a design heat recovery capacity > 40 percent of the design chiller cooling capacity.

Exception 3 to Section 140.4(i): Chillers used to charge thermal energy storage systems where the charging temperature is < 40°F.

Exception 4 to Section 140.4(i): In buildings with more than three chillers, only three chillers are required to meet the Path B efficiencies.

(j) **Limitation of air-cooled chillers.** Chilled water plants shall not have more than 300 tons provided by air-cooled chillers.

Exception 1 to Section 140.4(j): Where the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled chillers.

Exception 2 to Section 140.4(j): Chillers that are used to charge a thermal energy storage system with a design temperature of less than 40°F (4°C).

Exception 3 to Section 140.4(j): Systems serving healthcare facilities.

(k) **Hydronic system measures.**

1. **Hydronic variable flow systems.** HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50 percent or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

   Exception 1 to Section 140.4(k)1: Systems that include no more than three control valves.

   Exception 2 to Section 140.4(k)1: Systems having a total pump system power less than or equal to 1.5 hp.

2. **Chiller isolation.** When a chilled water system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.

3. **Boiler isolation.** When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).

4. **Chilled and hot water temperature reset controls.** Systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

   Exception 1 to Section 140.4(k)4: Hydronic systems that use variable flow to reduce pumping energy in accordance with 140.4(k)1.

   Exception 2 to Section 140.4(k)4: Systems serving healthcare facilities.

5. **Water-cooled air conditioner and hydronic heat pump systems.** Water circulation systems serving water-cooled air conditioners, hydronic heat pumps, or both that have total pump system power exceeding 5 hp shall have flow controls that meet the requirements of Section 140.4(k)6. Each such air conditioner or heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

6. **Variable flow controls.**

   A. Variable speed drives. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls or devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pumps shall be controlled as a function of required differential pressure.

   B. Pressure sensor location and setpoint.

      i. For systems without direct digital control of individual coils reporting to the central control panel, differential pressure shall be measured at the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

      ii. For systems with direct digital control of individual coils with a central control panel, the static pressure setpoint shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80 percent open. Pressure sensors may be mounted anywhere.

   Exception 1 to Section 140.4(k)6: Heating hot water systems.

   Exception 2 to Section 140.4(k)6: Condenser water systems serving only water-cooled chillers.

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7. **Hydronic heat pump (WLHP) controls.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature dead band of at least 20°F between initiation of heat rejection and heat addition by the central devices.

   Exception to Section 140.4(k)7: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, dead bands of less than 20°F shall be allowed.

8. **High capacity space heating gas boiler systems.** In Climate Zones 1 through 6, 9 through 14, and 16, gas hot water boiler systems for space heating with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h shall meet all of the following requirements.

   A. **Boiler system efficiency.** Gas hot water boilers shall have a minimum thermal efficiency of 90 percent. Systems with multiple boilers can meet this requirement if the space-heating input provided by equipment with thermal efficiencies above and below 90 percent has an input capacity-weighted average thermal efficiency of at least 90 percent. For boilers federally regulated by combustion efficiency, the calculation for the input capacity-weighted average thermal efficiency shall use the combustion efficiency value.

   B. **Hot water distribution design.** The hot water distribution system shall be designed to comply with Items i and ii.

      i. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F or less.

      ii. Under all operating conditions, the water temperature entering the boiler is 120°F or less or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be no greater than 20 percent of the design flow of the operating boilers.

   Exception 1 to Section 140.4(k)8: Where 25 percent of the annual space heating requirement is provided by on-site renewable energy, site-recovered energy or heat recovery chillers.

   Exception 2 to Section 140.4(k)8: Space heating boilers installed in individual dwelling units.

   Exception 3 to Section 140.4(k)8: Where 50 percent or more of the design heating load is served using perimeter convective heating, radiant ceiling panels or both.

   Exception 4 to Section 140.4(k)8: Individual gas boilers with input capacity less than 300,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

(l) **Reserved.**

(m) **Fan control.** Each cooling system listed in Table 140.4-I shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. DX and chilled water cooling systems that control the capacity of the mechanical cooling directly based on occupied space temperature shall
   A. Have a minimum of two stages of fan control with no more than 66 percent speed when operating on stage 1; and
   B. Draw no more than 40 percent of the fan power at full fan speed, when operating at 66 percent speed.
2. All other systems, including but not limited to DX cooling systems and chilled water systems that control the space temperature by modulating the airflow to the space, shall have proportional fan control such that at 50 percent air flow the power draw is no more than 30 percent of the fan power at full fan speed.
3. Systems that include an air side economizer to meet Section 140.4(e)1 shall have a minimum of two speeds of fan control during economizer operation.

Exception 1 to Section 140.4(m): Modulating fan control is not required for chilled water systems with all fan motors < 1 HP, or for evaporative systems with all fan motors < 1 HP, if the systems are not used to provide ventilation air and all indoor fans cycle with the load.

Exception 2 to Section 140.4(m): Systems serving healthcare facilities.

TABLE 140.4-I—FAN CONTROL SYSTEMS

COOLING SYSTEM TYPE	FAN MOTOR SIZE	COOLING CAPACITY
DX cooling	Any	≥ 65,000 Btu/hr
Chilled water and evaporative	≥ $^{1}/_{4}$ HP	Any

(n) **Mechanical system shut-off.** Any directly conditioned space with operable wall or roof openings to the outdoors shall be provided with interlock controls that disable or reset the temperature setpoint to 55°F for mechanical heating and disable or reset the temperature setpoint to 90°F for mechanical cooling to that space when any such opening is open for more than 5 minutes.

Exception 1 to Section 140.4(n): Interlocks are not required on doors with automatic closing devices.

Exception 2 to Section 140.4(n): Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space).

Exception 3 to Section 140.4(n): Healthcare facilities.

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(o) Exhaust system transfer air. Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

1. The supply flow required to meet the space heating or cooling load; or
2. The ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety Department, or by Section 120.1(c)3; or
3. The mechanical exhaust flow minus the available transfer air. Available transfer air shall be from another conditioned space or return air plenums on the same floor and same smoke or fire compartment, and that at their closest point are within 15 feet of each other.

Exception 1 to Section 140.4(o): Biosafety level classified laboratories 3 or higher.

Exception 2 to Section 140.4(o): Vivarium spaces.

Exception 3 to Section 140.4(o): Spaces that are required by applicable codes and standards to be maintained at a positive pressure differential relative to adjacent spaces.

Exception 4 to Section 140.4(o): Spaces where the highest amount of transfer air that could be used for exhaust makeup may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship.

Exception 5 to Section 140.4(o): Healthcare facilities.

(p) **Dedicated outdoor air systems (DOAS).** HVAC systems that utilize a dedicated outdoor air system (DOAS) such as a DX-DOAS, HRV or ERV unit to condition, temper or filter 100 percent outdoor air separate from local or central space-conditioning systems serving the same space shall meet the following criteria:

1. DOAS unit fan systems with input power less than 1 kW shall not exceed a total combined fan power of 1.0 W/cfm. DOAS with fan power greater than or equal to 1 kW shall meet the requirements of Section 140.4 (c).

   Exception to Section 140.4(p)1: DOAS complying with Section 140.4(a)3E.
2. The DOAS supply air shall be delivered directly to the occupied space or at the outlet of any terminal heating or cooling coils and shall cycle off any zone heating and cooling equipment fans, circulation pumps and terminal unit fans when there is no call for heating or cooling in the zone.

   Exception 1 to Section 140.4(p)2: Active chilled beam systems.

   Exception 2 to Section 140.4(p)2: Sensible-only cooling terminal units with pressure-independent variable-airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.

   Exception 3 to Section 140.4(p)2: Any configuration where a DOAS unit provides ventilation air to a downstream fan (a terminal box, air handling unit or other space-conditioning equipment) where the total system airflow can be reduced to ventilation minimum or the downstream fan power is no greater than 0.12 watts per cfm when space temperatures are within the thermostat deadband (at low speed per manufacturer's literature).
3. DOAS supply and exhaust fans shall have a minimum of three speeds to facilitate system balancing.
4. DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 60°F when representative building loads or outdoor air temperature indicates that the majority of zones require cooling.

(q) **Exhaust air heat recovery.** Fan systems designed to operate to the criteria listed in Table 140.4-J, Table 140.4-K, or where required by Section 140.4(a)3, shall include an exhaust air heat recovery system that meets the following:

1. A sensible energy recovery ratio of at least 60 percent or an enthalpy recovery ratio of at least 50 percent for both heating and cooling design conditions and a rating in accordance with AHRI 1060.

   Exception 1 to Section 140.4(q)1: Compliance is not required for sensible recovery ratio at heating design conditions for Climate Zone 15.

   Exception 2 to Section 140.4(q)1: Compliance is not required for sensible recovery ratio at cooling design conditions for Climate Zone 1.
2. Energy recovery bypass or control to disable energy recovery and to directly economize with ventilation air based on outdoor air temperature limits specified in Table 140.4-G. For energy recovery systems where the transfer of energy cannot be stopped, bypass shall prevent the total airflow rate of either outdoor air or exhaust air through the energy recovery exchanger from exceeding 10 percent of the full design airflow rate.

   Exception to Section 140.4(q)2: For DOAS units with the capability to shut off when a separate space-conditioning system serving the same space meets the economizer requirements in Section 140.4(e)1A.

Exception 1 to Section 140.4(q): Systems meeting Section 140.9(c), Prescriptive requirements for laboratory and factory exhaust systems.

Exception 2 to Section 140.4(q): Systems serving spaces that are not cooled and that are heated to less than 60°F.

Exception 3 to Section 140.4(q): Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy in Climate Zone 16.

Exception 4 to Section 140.4(q): Where the sum of the airflow rates exhausted and relieved within 20 feet of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is either:

1. Used for another energy recovery system,

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2. Not allowed by the *California Mechanical Code* (Title 24, Part 4) (CMC) for use in energy recovery systems with leakage potential, or
3. Of Class 4 as specified in Section 120.1(g).

Exception 5 to Section 140.4(q): Systems expected to operate less than 20 hours per week.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

TABLE 140.4-J—ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (< 8,000 HOURS/YEAR)

% OUTDOOR AIR AT FULL DESIGN AIRFLOW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥ 10% and < 20%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
≥ 20% and < 30%	≥ 15,000	≥ 20,000	NR	NR	NR	NR	NR	NR	NR	NR	≥ 18,500	≥ 18,500	≥ 18,500	≥ 18,500	≥ 18,500	≥ 18,500
≥ 30% and < 40%	≥ 13,000	≥ 15,000	NR	NR	NR	NR	NR	NR	NR	NR	≥ 15,000	≥ 15,000	≥ 15,000	≥ 15,000	≥ 15,000	≥ 15,000
≥ 40% and < 50%	≥ 10,000	≥ 12,000	NR	NR	NR	NR	NR	NR	NR	≥ 22,000	≥ 10,000	≥ 10,000	≥ 10,000	≥ 10,000	≥ 10,000	≥ 10,000
≥ 50% and < 60%	≥ 9,000	≥ 10,000	NR	≥ 18,500	NR	NR	NR	NR	NR	≥ 17,000	≥ 8,000	≥ 8,000	≥ 8,000	≥ 8,000	≥ 8,000	≥ 8,000
≥ 60% and < 70%	≥ 7,000	≥ 7,500	NR	≥ 16,500	NR	NR	NR	NR	≥ 20,000	≥ 15,000	≥ 7,000	≥ 7,000	≥ 7,000	≥ 7,000	≥ 7,000	≥ 7,000
≥ 70% and < 80%	≥ 6,500	≥ 7,000	NR	≥ 15,000	NR	NR	NR	NR	≥ 17,000	≥ 14,000	≥ 5,000	≥ 5,000	≥ 5,000	≥ 5,000	≥ 5,000	≥ 5,000
≥ 80%	≥ 4,500	≥ 6,500	NR	≥ 14,000	NR	NR	NR	NR	≥ 15,000	≥ 13,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000

1. Flow rates in Table 140.4-J represent the design supply fan airflow rate in cfm.
2. For a DOAS unit providing outdoor air to another space-conditioning system, the full design supply fan airflow rate shall be the total airflow of only the DOAS unit.

TABLE 140.4-K—ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (≥ 8,000 HOURS/YEAR)

% OUTDOOR AIR AT FULL DESIGN AIRFLOW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥ 10% and < 20%	≥ 10,000	≥ 10,000	NR	NR	NR	NR	NR	NR	NR	≥ 40,000	≥ 40,000	≥ 20,000	≥ 10,000	≥ 10,000	≥ 10,000	≥ 10,000
≥ 20% and < 30%	≥ 2,000	≥ 5,000	≥ 13,000	≥ 9,000	≥ 9,000	NR	NR	NR	NR	≥ 15,000	≥ 15,000	≥ 5,000	≥ 5,000	≥ 5,000	≥ 5,000	≥ 5,000
≥ 30% and < 40%	≥ 2,000	≥ 3,000	≥ 10,000	≥ 6,500	≥ 6,500	NR	NR	NR	≥ 15,000	≥ 7,500	≥ 7,500	≥ 3,000	≥ 3,000	≥ 3,000	≥ 3,000	≥ 3,000
≥ 40% and < 50%	≥ 2,000	≥ 2,000	≥ 8,000	≥ 6,000	≥ 6,000	NR	NR	NR	≥ 12,000	≥ 6,000	≥ 6,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000
≥ 50% and < 60%	≥ 2,000	≥ 2,000	≥ 7,000	≥ 6,000	≥ 6,000	NR	NR	≥ 20,000	≥ 10,000	≥ 5,000	≥ 5,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000
≥ 60% and < 70%	≥ 2,000	≥ 2,000	≥ 6,000	≥ 6,000	≥ 6,000	NR	NR	≥ 18,000	≥ 9,000	≥ 4,000	≥ 4,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000
≥ 70% and < 80%	≥ 2,000	≥ 2,000	≥ 6,000	≥ 5,000	≥ 5,000	NR	NR	≥ 15,000	≥ 8,000	≥ 3,000	≥ 3,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000
≥ 80%	≥ 2,000	≥ 2,000	≥ 6,000	≥ 5,000	≥ 5,000	NR	NR	≥ 12,000	≥ 7,000	≥ 3,000	≥ 3,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000	≥ 2,000

1. Flow rates in Table 140.4-K represent the design supply fan airflow rate in cfm.
2. For a DOAS unit providing outdoor air to another space-conditioning system, the full design supply fan airflow rate shall be the total airflow of only the DOAS unit.

(r) **DDC controller logic using ASHRAE Guideline 36.** HVAC systems with DDC controllers shall use controller logic originating from a programming library based on sequences of operation from ASHRAE Guideline 36 in accordance with the following:

1. Requirement applies to all controllers that are capable of being programmed in the field; and
2. Requirement applies to the entirety or all applicable portions of equipment control for configurations included in the programming library; and
3. The programming library shall be certified to the Energy Commission as meeting the requirements of Reference Joint Appendix JA18.

   Exception to Section 140.4(r)3: Nonprogrammable (configurable-only) controllers for zone terminal units shall follow applicable ASHRAE Guideline 36 zone sequences referenced in Reference Joint Appendix JA18, Table 18.3-1, but are not subject to certification requirements.

Exception 1 to Section 140.4(r): Logic from the certified programming library modified to suit application-specific operations that are not included in ASHRAE Guideline 36 sequences.

Exception 2 to Section 140.4(r): Systems serving healthcare facilities.

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(s) **Mechanical heat recovery.**

1. **Simultaneous mechanical heat recovery.**
   A. Simultaneous mechanical heat recovery is required for newly constructed buildings that meet either i or ii:
      i. CHL + 0.1 × CLL ≥ 200 tons and SWHCAP + HCAP ≥ 2200 kBtuh; or
      ii. CCAP ≥ 300 tons and SWHCAP + 0.1 × HCAP ≥ 700 kBtuh

   where:

   CCAP = Design capacity of all mechanical cooling systems.

   CHL = Coincident peak cooling load of all spaces with a design equipment power density > 5 watts/ft^2 and a minimum outdoor airflow requirement < 0.5 cfm/ft^2 (i.e., high load spaces).

   CLL = CCAP - CHL. If the design includes capacity for future cooling systems, then assume 20 percent of future systems serve high load spaces.

   SWHCAP = Design capacity of all service water heating (SWH) systems, excluding systems expected to operate less than 5 hours per week, such as instant-hot water systems for emergency eyewash stations.

   HCAP = Design capacity of all space-heating systems.

   B. The heat recovery system shall include a heat recovery chiller, or other means, capable of transferring the lesser of the following from spaces in cooling to spaces in heating and/or to the SWH system:
      i. 25 percent of the peak heat rejection of the cooling system.
      ii. 25 percent of (SWHCAP + HCAP)

   Exception 1 to Section 140.4(s)1: Laboratory buildings with exhaust air heat recovery systems meeting Section 140.9(c)6.

   Exception 2 to Section 140.4(s)1: Buildings in Climate Zone 15 with SWHCAP < 600 kBtuh.

2. **Heat recovery for service water heating.**

   If the building is required to have simultaneous mechanical heat recovery by Section 140.4(s)1, and SWHCAP ≥ 500 kBtuh, then the heat recovery system shall also heat or preheat the service hot water. The heat recovery system shall have the capacity to transfer the smaller of:

   A. 30 percent of the peak heat rejection of the cooling system; or
   B. 30 percent of SWHCAP.

Exception to Section 140.4(s): Buildings with a computer room heat recovery system or wastewater heat recovery system capable of providing not less than 25 percent of SWHCAP + HCAP.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code*.

SECTION 140.5—PRESCRIPTIVE REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS

(a) **Nonresidential occupancies.** Service water-heating systems in nonresidential buildings shall meet the requirements of 1 or 2 below, or meet the performance compliance requirements of Section 140.1:

1. **School buildings less than 25,000 square feet and less than 4 stories in Climate Zones 2 through 15.** A heat pump water-heating system that meets the applicable requirements of Sections 110.1, 110.3 and 120.3.

   Exception to Section 140.5(a)1: A water-heating system serving an individual bathroom space may be an instantaneous electric water heater.

2. **All other occupancies.** A service water-heating system that meets the applicable requirements of Sections 110.1, 110.3, 120.3 and 140.5(c).

(b) **Hotel/motel occupancies.** A service water-heating system installed in hotel/motel buildings shall meet the requirements of Section 170.2(d).

(c) **High-capacity service water-heating systems**. Gas service water-heating systems with a total installed gas water-heating input capacity of 1 MMBtu/h or greater shall have gas service water-heating equipment with a minimum thermal efficiency of 90 percent. Multiple units can meet this requirement if the water-heating input provided by equipment with thermal efficiencies above and below 90 percent averages out to an input capacity-weighted average of at least 90 percent.

Exception 1 to Section 140.5(c): If 25 percent of the annual service water-heating requirement is provided by site-solar energy or site-recovered energy.

Exception 2 to Section 140.5(c): Water heaters installed in individual dwelling units.

Exception 3 to Section 140.5(c): Individual gas water heaters with input capacity at or below 100,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

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SECTION 140.6—PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

A building complies with this section if:

i. The calculation of adjusted indoor lighting power of all proposed building areas combined, calculated under Subsection (a) is no greater than the calculation of allowed indoor lighting power, specific methodologies calculated under Subsection (c); and

ii. The calculation of allowed indoor lighting power, general rules comply with Subsection (b).

The prescriptive limits on indoor lighting power are the smaller of the adjusted and allowed indoor lighting power values determined in accordance with Item i.

(a) **Calculation of adjusted indoor lighting power.** The adjusted indoor lighting power of all proposed building areas is the total watts of all planned permanent and portable lighting systems in all areas of the proposed building; subject to the applicable adjustments under Subdivisions 1 through 4 of this subsection and the requirements of Subdivision 4 of this subsection.

1. **Two interlocked lighting systems.** No more than two lighting systems may be used for an area, and if there are two they must be interlocked. Where there are two interlocked lighting systems, the watts of the lower wattage system may be excluded from the adjusted indoor lighting power density if:
   A. An installation certificate detailing compliance with Section 140.6(a)1 is submitted in accordance with Sections 10-103 and 130.4; and
   B. The area or areas served by the interlocking systems is an auditorium, a convention center, a conference room, a multipurpose room or a theater; and
   C. The two lighting systems are interlocked with a nonprogrammable double-throw switch to prevent simultaneous operation of both systems.

   For compliance with Part 6 a nonprogrammable double-throw switch is an electrical switch commonly called a “single pole double throw” or “three-way” switch that is wired as a selector switch allowing one of two loads to be enabled. It can be a line voltage switch or a low voltage switch selecting between two relays. It cannot be overridden or changed in any manner that would permit both loads to operate simultaneously.
2. **Reduction of wattage through controls.** In calculating adjusted indoor lighting power, the installed watts of a luminaire providing general lighting in an area listed in Table 140.6-A may be reduced by the product of (i) the number of watts controlled as described in Table 140.6-A, times (ii) the applicable power adjustment factor (PAF), if all of the following conditions are met:
   A. An installation certificate is submitted in accordance with Section 130.4(b), and
   B. Luminaires and controls meet the applicable requirements of Section 110.9, and Sections 130.0 through 130.5; and
   C. The controlled lighting is permanently installed general lighting systems and the controls are permanently installed nonresidential-rated lighting controls.

      When used for determining PAFs for general lighting in offices, furniture mounted luminaires that comply with all of the following conditions shall qualify as permanently installed general lighting systems:
      i. The furniture mounted luminaires shall be permanently installed no later than the time of building permit inspection; and
      ii. The furniture mounted luminaires shall be permanently hardwired; and
      iii. The furniture mounted lighting system shall be designed to provide indirect general lighting; and
      iv. Before multiplying the installed watts of the furniture mounted luminaire by the applicable PAF, 0.2 watts per square foot of the area illuminated by the furniture mounted luminaires shall be subtracted from installed watts of the furniture mounted luminaires; and
      v. The lighting control for the furniture mounted luminaire complies with all other applicable requirements in Section 140.6(a)2.
   D. At least 50 percent of the light output of the controlled luminaire is within the applicable area listed in Table 140.6-A. Luminaires on lighting tracks shall be within the applicable area in order to qualify for a PAF.
   E. Only one PAF from Table 140.6-A may be used for each qualifying luminaire. PAFs shall not be added together unless allowed in Table 140.6-A.
   F. Only lighting wattage directly controlled in accordance with Section 140.6(a)2 shall be used to reduce the installed watts as allowed by Section 140.6(a)2 for calculating the Adjusted Indoor Lighting Power. If only a portion of the wattage in a luminaire is controlled in accordance with Section 140.6(a)2, then only that portion of controlled wattage may be reduced in calculating adjusted indoor lighting power.
   G. Lighting controls used to qualify for a PAF shall be designed and installed in addition to manual, multilevel, and automatic lighting controls required in Section 130.1, and in addition to any other lighting controls required by any provision of Part 6. PAFs shall not be available for lighting controls required by Part 6.
   H. To qualify for the PAF for daylight continuous dimming plus OFF control, the daylight control and controlled luminaires shall comply with Section 130.1(d), 130.4(a)3 and 130.4(a)7, and the daylight control shall be continuous dimming and shall additionally turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power. The PAF shall apply to the luminaires in the primary sidelit daylit zone, secondary sidelit daylit zone and skylit daylit zone.

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I. To qualify for the PAF for an occupant sensing control controlling the general lighting in large office areas above workstations, in accordance with Table 140.6-A, the following requirements shall be met:
   i. The office area shall be greater than 250 square feet; and
   ii. This PAF shall be available only in office areas which contain workstations; and
   iii. Controlled luminaires shall only be those that provide general lighting directly above the controlled area, or furniture mounted luminaires that comply with Section 140.6(a)2 and provide general lighting directly above the controlled area; and
   iv. Qualifying luminaires shall be controlled by occupant sensing controls that meet all of the following requirements, as applicable:
      a. Infrared sensors shall be equipped by the manufacturer, of fitted in the field by the installer, with lenses or shrouds to prevent them from being triggered by movement outside of the controlled area.
      b. Ultrasonic sensors shall be tuned to reduce their sensitivity to prevent them from being triggered by movements outside of the controlled area.
      c. All other sensors shall be installed and adjusted as necessary to prevent them from being triggered by movements outside of the controlled area.
   v. Occupant sensing control zones, in offices greater than 250 square feet, shall be shown on the plans.

J. To qualify for the PAF for an Institutional Tuning in Table 140.6-A, the tuned lighting system shall comply with all of the following requirements:
   i. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and
   ii. The means of setting the limit is accessible only to authorized personnel; and
   iii. The setting of the limit is verified by the acceptance test required by Section 130.4(a)7; and
   iv. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85 percent of full light output or full power draw.

K. To qualify for the PAF for a demand responsive control in Table 140.6-A, the general lighting wattage receiving the PAF shall not be within the scope of Section 110.12(c) and a demand responsive control shall meet all of the following requirements:
   i. The controlled lighting shall be capable of being automatically reduced in response to a demand response signal; and
   ii. General lighting shall be reduced in a manner consistent with the requirements of Section 130.1(b).

L. To qualify for the PAFs for clerestory fenestration, horizontal slats, or light shelves in Table 140.6-A, the daylighting design shall meet the requirements in Section 140.3(d). The PAFs shall only apply to lighting in a primary or secondary sidelit daylit zone where continuous dimming daylighting controls meeting the requirements of Section 130.1(d) are installed.

TABLE 140.6-A—LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA	FACTOR
1. Daylight continuous dimming plus OFF control	Luminaires in skylit daylit zone or primary sidelit daylit zone or secondary sidelit daylit zone	0.10
2. Occupant sensing controls in offices larger than 250 square feet	One sensor controlling an area that is no larger than 125 square feet	0.30
3. Occupant sensing controls in offices larger than 250 square feet	One sensor controlling an area that is 126-250 square feet	0.20
4. Institutional tuning	Luminaires in non-daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.10
	Luminaires in daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.05
5. Demand responsive control	General lighting luminaires not in the scope of Section 110.12(c). If DR controls are required of Section 110.12(c), this PAF is not available for any lighting in the project. Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF.	0.05
6. Clerestory fenestration	Luminaires in daylit areas adjacent to the clerestory. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.05
7. Horizontal slats	Luminaires in daylit areas adjacent to vertical fenestration with interior or exterior horizontal slats. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.05
8. Light shelves	Luminaires in daylit areas adjacent to clerestory fenestration with interior or exterior light shelves. This PAF may be combined with the PAF for clerestory fenestration. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.10

a. To qualify for any of the power adjustment factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2.
b. Only one PAF may be used for each qualifying luminaire unless combined below.
c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF.

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3. **Lighting wattage excluded.** The watts of the following indoor lighting applications may be excluded from adjusted indoor lighting power. (Indoor lighting not listed below shall comply with all applicable nonresidential indoor lighting requirements in Part 6):
   A. In theme parks: lighting for themes and special effects;
   B. Studio lighting for film or photography, provided that these lighting systems are in addition to and separately switched from a general lighting system;
   C. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for religious worship, provided that these lighting systems are additions to a general lighting system and are separately controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators;

      Lighting intended for makeup, hair, and costume preparation in performing arts facility dressing rooms, provided that the lighting is separately switched from the general lighting system, switched independently at each dressing station, and is controlled with a vacancy sensor.
   D. In civic facilities, transportation facilities, convention centers and hotel function areas: lighting for temporary exhibits, if the lighting is in addition to a general lighting system, and is separately controlled from a panel accessible only to authorized operators;
   E. Lighting installed by the manufacturer in walk-in coolers or freezers, vending machines, food preparation equipment, and scientific and industrial equipment;
   F. Examination and surgical lights, low ambient night lights and lighting integral to medical equipment, provided that these lighting systems are additions to and separately switched from a general lighting system;
   G. Lighting for plant growth or maintenance in non-CEH spaces, if it is controlled by a multilevel astronomical time-switch control that complies with the applicable provisions of Section 110.9;
   H. Lighting equipment that is for sale;
   I. Lighting demonstration equipment in lighting education facilities;
   J. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations;
   K. Exitway or egress illumination that is normally off and that is subject to the CBC;
   L. In hotel/motel buildings, lighting in guest rooms (lighting in hotel/motel guestrooms shall comply with Section 130.0(b). (Indoor lighting not in guestrooms shall comply with all applicable nonresidential lighting requirements in Part 6.)
   M. Reserved.
   N. Temporary lighting systems.
   O. Lighting in occupancy group U buildings less than 1,000 square feet;
   P. Lighting in unconditioned agricultural buildings less than 2,500 square feet;
   Q. Lighting systems in qualified historic buildings, as defined in the *California Historical Building Code* (Title 24, Part 8), are exempt from the lighting power density allowances, if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other lighting systems in qualified historic buildings shall comply with the lighting power density allowances;
   R. Lighting in nonresidential parking garages for seven or fewer vehicles: Lighting in nonresidential parking garages for seven or fewer vehicles shall comply with the applicable residential parking garage provisions of Section 150.0(k).
   S. Lighting for signs: Lighting for signs shall comply with Section 140.8.
   T. Lighting in refrigerated cases less than 3,000 square feet. (Lighting in refrigerated cases less than 3,000 square feet shall comply with the Title 20 Appliance Efficiency Regulations).
   U. Lighting in elevators where the lighting meets the requirements in Section 120.6(f).
   V. Lighting connected to a Life Safety Branch or Critical Branch, as specified in Section 517 of the *California Electrical Code.*
   W. Horticultural lighting in CEH spaces (indoor growing and greenhouses) complying with Section 120.6(h).
4. **Luminaire classification and power adjustment.**
   A. Luminaire classification and power shall be determined in accordance with Section 130.0(c).
   B. Small aperture tunable-white and dim-to-warm luminaires lighting power adjustment. For qualifying small aperture tunable-white and dim-to-warm LED luminaires, the adjusted indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage by 0.80. Qualifying luminaires shall meet all of the following:
      i. Small aperture. Qualifying luminaires with a luminaire aperture length longer than 18 inches shall have a luminaire aperture no wider than four inches. Qualifying luminaires with a luminaire aperture length of 18 inches or less shall have a luminaire aperture no wider than eight inches.
      ii. Color changing. qualifying tunable-white luminaires shall be capable of a color change greater than or equal to 2,000 Kelvin correlated color temperature (CCT). Qualifying dim-to-warm luminaires shall be capable of color change greater than or equal to 500 Kelvin CCT.
      iii. Controls. Qualifying luminaires shall be connected to controls that allows color changing of the luminaires.

(b) **Calculation of allowed indoor lighting power: general rules.**

1. The allowed indoor lighting power allotment for conditioned areas shall be calculated separately from the allowed lighting power allotment for unconditioned areas. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between conditioned and unconditioned area allotments.
2. Allowed indoor lighting power allotment shall be calculated separately from the allowed outdoor lighting power allotment. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between the separate indoor and outdoor allotments.
3. The allowed indoor lighting power density allotment for general lighting shall be calculated as follows:
   A. The complete building method, as described in Section 140.6(c)1, shall be used only for an entire building, except as permitted by Section 140.6(c)1. As described more fully in Section 140.6(c)1, and subject to the adjustments listed there, the allowed indoor lighting power allotment for general lighting for the entire building shall be calculated as follows:
      i. For a conditioned building, the product of the square feet of conditioned space of the building times the applicable allotment of watts per square foot described in Table 140.6-B.
      ii. For an unconditioned building, the product of the square foot of unconditioned space of the building times the applicable allotment of watts per square feet described in Table 140.6-B.

TABLE 140.6-B—COMPLETE BUILDING METHOD LIGHTING POWER DENSITY VALUES

TYPE OF BUILDING	ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)
Assembly building	0.65
Bank or financial institution building	0.65
Grocery store building	0.90
Gymnasium building	0.60
Healthcare facility	0.90
Industrial/manufacturing facility building	0.60
Library building	0.70
Motion picture theater building	0.60
Museum building	0.65
Office building	0.60
Parking garage building	0.13
Performing arts theater building	0.75
Religious facility building	0.70
Restaurant building	0.65
Retail store building	0.90
School building	0.60
Sports arena building	0.75
All other buildings	0.40

   B. The area category method, as described in Section 140.6(c)2, shall be used for all areas in the building. Under the area category method, as described more fully in Section 140.6(c)2, and subject to the adjustments listed there, the allowed indoor lighting power allotment for general lighting shall be calculated for each area in the building as follows:
      i. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 140.6-C.
      ii. For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 140.6-C.

   The allowed indoor lighting power allotment for general lighting for one area for which the area category method was used may be increased up to the amount that the allowed indoor lighting power allotment for general lighting for another area using the area category method is decreased, except that such increases and decreases shall not be made between conditioned and unconditioned space.

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TABLE 140.6-C—AREA CATEGORY METHOD—LIGHTING POWER DENSITY VALUES (WATTS/FT²)

BUILDING TYPE/USE	PRIMARY FUNCTION AREA	ALLOWED LIGHTING POWER DENSITY FOR GENERAL LIGHTING (W/ft²)	ADDITIONAL LIGHTING POWER[1]	
			Qualified Lighting Systems	Additional Allowance[3] (W/ft², unless noted otherwise)
Aging Eye/Low-Vision[11]	Corridor Area	0.70	Decorative/display	0.30
	Dining	0.80	Decorative/display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Lobby, Main Entry	0.85	Decorative/display	0.30
			Transition lighting OFF at night[12]	0.95
			Tunable white or dim-to-warm[10]	0.10
	Lounge/Waiting Area	0.80	Decorative/display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Multipurpose Room	0.85	Decorative/display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Religious Worship Area	1.00	Decorative/display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Restroom	1.00	Decorative/display	0.20
	Stairwell	0.80	Decorative/display	0.30
Audience Seating Area	NA	0.50	Decorative/display	0.25
Auditorium Area	NA	0.70	Decorative/display	0.45
Auto Repair / Maintenance Area	NA	0.55	Detailed task work[7]	0.20
Barber, Beauty Salon, Spa Area	NA	0.70	Detailed task work[7]	0.30
	NA		Decorative/display	0.25
Civic Meeting Place Area	NA	0.90	Decorative/display	0.25
Classroom, Lecture, Training, Vocational Area	NA	0.60	White or chalk board[1]	7 W/ft
Concourse and Atrium Area	NA	0.60	Decorative/display	0.25
> Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Decorative	0.25
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Wall Display MH ≤ 10′6″	2 W/ft
	NA	0.75	Wall Display MH 10′7″- 14′	2.35 W/ft
	NA	0.75	Wall Display MH > 14′	2.66 W/ft
	NA	0.75	Floor Display & Task MH ≤ 10′6″	0.30
	NA	0.75	Floor Display & Task MH 10′7″- 14′	0.35
	NA	0.75	Floor Display & Task MH > 14′	0.40
Copy Room	NA	0.50	NA	NA
Corridor Area	NA	0.40	Decorative/display	0.25
> Dining Area	Bar/Lounge and Fine Dining	0.45	Decorative	0.35
		0.45	Wall Display MH ≤ 10′6″	1.25 W/ft
		0.45	Wall Display MH 10′7″- 14′	1.5 W/ft
		0.45	Wall Display MH > 14′	1.7 W/ft
		0.45	Floor Display & Task MH ≤ 10′6″	0.45
		0.45	Floor Display & Task MH 10′7″- 14′	0.52
		0.45	Floor Display & Task MH > 14′	0.60
		0.45	General Lighting in the enclosed space of ceiling height > 10′	0.25
	Cafeteria/Fast Food	0.45	NA	0.25
	Family and Leisure	0.40	NA	0.25
Electrical, Mechanical, Telephone Rooms	NA	0.40	Detailed task work[7]	0.20
Exercise/Fitness Center and Gymnasium Area	NA	0.50	NA	NA

TABLE 140.6-C—AREA CATEGORY METHOD—LIGHTING POWER DENSITY VALUES (WATTS/FT²)—continued

BUILDING TYPE/USE	PRIMARY FUNCTION AREA	ALLOWED LIGHTING POWER DENSITY FOR GENERAL LIGHTING (W/ft²)	ADDITIONAL LIGHTING POWER[1]	
			Qualified Lighting Systems	Additional Allowance[3] (W/ft², unless noted otherwise)
Financial Transaction Area	NA	0.70	Decorative/display	0.25
Healthcare Facility and Hospital	Exam/Treatment Room	1.15	NA	NA
	Imaging Room	0.60	Decorative/display	0.20
			Tunable white or dim-to-warm[10]	0.10
	Medical Supply Room	0.55	NA	NA
	Nursery	0.80	Tunable white or dim-to-warm[10]	0.10
	Nurse's Station	0.85	Tunable white or dim-to-warm[10]	0.10
			Detailed task work[7]	0.20
	Operating Room	1.90	NA	NA
	Patient Room	0.70	Decorative/display	0.15
			Tunable white or dim-to-warm[10]	0.10
	Physical Therapy Room	0.75	Tunable white or dim-to-warm[10]	0.10
	Recovery Room	0.90	Tunable white or dim-to-warm[10]	0.10
Hotel Function Area	NA	0.85	Decorative/display	0.25
Kitchen/Food Preparation Area	NA	0.95	NA	NA
Laboratory, Scientific	NA	0.90	Specialized task work[8]	0.35
Laundry Area	NA	0.45	NA	NA
Library	Reading Area	0.80	Decorative/display	0.25
	Stacks Area	1.00	NA	NA
Lobby, Main Entry	NA	0.70	Decorative	0.25
	NA	0.70	Wall Display MH ≤ 10′6″	3 W/ft
	NA	0.70	Wall Display MH 10′7″- 14′	3.5 W/ft
	NA	0.70	Wall Display MH > 14′	4 W/ft
Locker Room	NA	0.45	NA	NA
Lounge, Breakroom, or Waiting Area	NA	0.55	Decorative/display	0.25
Manufacturing, Commercial & Industrial Work Area	Low Bay	0.60	Detailed task work[7]	0.20
	High Bay	0.65	Detailed task work[7]	0.20
	Precision	0.85	Precision specialized work[9]	0.70
Museum Area	Exhibition/Display	0.60	Decorative/display	0.45
	Restoration Room	0.70	Detailed task work[7]	0.35
Office Area	> 250 square feet	0.60	Decorative/display and portable lighting for office areas[6]	0.20
	≤ 250 square feet	0.65		
Parking Garage Area	Parking Zone and Ramps	0.10	First ATM or ticket machine	100 W
	Daylight Adaptation Zones[2]	1.00	Additional ATM or ticket machine	50 W each
Pharmacy Area	NA	1.00	Specialized task work[8]	0.35

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TABLE 140.6-C—AREA CATEGORY METHOD—LIGHTING POWER DENSITY VALUES (WATTS/FT²)—continued

BUILDING TYPE/USE	PRIMARY FUNCTION AREA	ALLOWED LIGHTING POWER DENSITY FOR GENERAL LIGHTING (W/ft²)	ADDITIONAL LIGHTING POWER[1]	
			Qualified Lighting Systems	Additional Allowance[3] (W/ft², unless noted otherwise)
Retail Sales Area	Grocery Sales	1.00	Decorative	0.35
		1.00	Wall Display MH ≤ 10′6″	6.6 W/ft
		1.00	Wall Display MH 10′7″- 14′	7.76 W/ft
		1.00	Wall Display MH > 14′	8.8 W/ft
		1.00	Floor Display & Task MH ≤ 10′6″	0.60
		1.00	Floor Display & Task MH 10′7″- 14′	0.70
		1.00	Floor Display & Task MH > 14′	0.80
		1.00	General Lighting in the enclosed space of ceiling height > 10’	0.10
	Retail Merchandise Sales	0.95	Decorative	0.35
		0.95	Wall Display MH ≤ 10′6″	9.5 W/ft
		0.95	Wall Display MH 10′7″- 14′	11.2 W/ft
		0.95	Wall Display MH > 14′	12.7 W/ft
		0.95	Floor Display & Task MH ≤ 10′6″	0.45
		0.95	Floor Display & Task MH 10′7″- 14′	0.52
		0.95	Floor Display & Task MH > 14′	0.60
		0.95	Valuable Display Case	0.50
		0.95	General Lighting in the enclosed space of ceiling height > 10′	0.10
	Fitting Room	0.60	External illuminated mirror[5]	40 W each
			Internal illuminated mirror[5]	120 W each
Religious Worship Area	NA	0.95	Decorative/display	0.25
Restrooms	NA	0.65	Decorative/display	0.35
Stairwell	NA	0.60	Decorative/display	0.35
Storage, Commercial/Industrial	Warehouse	0.40	NA	NA
	Shipping & Handling	0.60		
Sports Arena—Playing Area	Class I Facility[13]	2.25	NA	NA
	Class II Facility[13]	1.45		
	Class III Facility[13]	1.10		
	Class IV Facility[13]	0.75		
Theater Area	Motion Picture	0.50	Decorative/display	0.25
	Performance	0.80		
Transportation Function	Baggage Area	0.40	NA	NA
	Ticketing Area	0.45	Decorative/display	0.20
Videoconferencing Studio	NA	0.90	Videoconferencing[14]	1.00
All other	NA	0.40	NA	NA

1. White board or chalk board: directional lighting dedicated to a white board or chalk board.
2. Daylight adaptation zones shall be no longer than 66 feet from the entrance to the parking garage.
3. MH denotes the luminaire mounting height of the qualified lighting systems.
4. Reserved.
5. Illuminated mirrors: lighting shall be dedicated to the mirror.
6. Portable lighting in office areas includes under-shelf or furniture-mounted supplemental task lighting when controlled by a time clock or an occupancy sensor.
7. Detailed task work: lighting provides the high level of visual acuity needed for activities that require close attention to small elements and/or extreme close-up work.
8. Specialized task work: lighting provides for small-scale, cognitive or fast-performance visual tasks; lighting required for operating specialized equipment associated with pharmaceutical/laboratorial activities.
9. Precision specialized work: lighting for work performed within a commercial or industrial environment that entails working with low-contrast, finely detailed or fast-moving objects.
10. Tunable white luminaires capable of color change greater than or equal to 2000K CCT, or dim-to-warm luminaires capable of color change greater than or equal to 500K CCT, connected to controls that allow color changing of the luminaires.
11. Aging eye/low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for senior long-term care, adult day care, senior support and/or people with special visual needs.
12. Transition lighting OFF at night. Lighting power controlled by astronomical time clock or other control to shut off lighting at night. Additional LPD only applies to area within 30 feet of an exit. Not applicable to lighting in daylit zones.
13. Class I facility is used for competition play for 5000 or more spectators. Class II facility is used for competition play for up to 5000 spectators. Class III facility is used for competition play for up to 2000 spectators. Class IV facility is normally used for recreational play and there is limited or no provision for spectators.
14. The additional videoconferencing lighting power shall be allowed provided the videoconferencing studio meets all the requirements of Section 140.6(c)2Gvii.

4. Allowed indoor lighting power allotments for all lighting power allotments other than general lighting shall be restricted as follows:

   When using the area category method, allowed indoor lighting power allotments for specialized task work, precision commercial and industrial work, white board or chalk board, accent, display, decorative, videoconferencing studio, wall display, floor display, task, or very valuable display case, may not be increased as a result of, or otherwise traded off against, decreasing any other allotment.

(c) **Calculation of allowed indoor lighting power: specific methodologies.** The allowed indoor lighting power for each building type, or each primary function area shall be calculated using only one of the methods in Subsection 1 or 2 below as applicable.

1. **Complete building method.** Requirements for using the complete building method include all of the following:
   A. The complete building method shall be used only for building types, as defined in Section 100.1, that are specifically listed in Table 140.6-B. (For example, retail and wholesale stores, hotel/motel, and high-rise residential buildings shall not use this method.)
   B. The complete building method shall be used only on projects involving:
      i. Entire buildings with one type of use occupancy; or
      ii. Mixed occupancy buildings where one type of use makes up at least 90 percent of the entire building (in which case, when applying the complete building method, it shall be assumed that the primary use is 100 percent of the building); or
      iii. A tenant space where one type of use makes up at least 90 percent of the entire tenant space (in which case, when applying the complete building method, it shall be assumed that the primary use is 100 percent of the tenant space).
   C. The complete building method shall be used only when the applicant is applying for a lighting permit and submits plans and specifications for the entire building or the entire tenant space.
   D. Under the complete building method, the allowed indoor lighting power allotment is the lighting power density value times the floor area of the entire building.
   E. For buildings including a parking garage plus another type of use listed in Table 140.6-B, the parking garage portion of the building and other type of use portion of the building shall each separately use the Complete Building Method.
2. **Area category method.** Requirements for using the area category method include all of the following:
   A. The area category method shall be used only for primary function areas, as defined in Section 100.1, that are listed in Table 140.6-C. For primary function areas not listed, selection of a reasonably equivalent type shall be permitted.
   B. Primary function areas in Table 140.6-C shall not apply to a complete building. Each primary function area shall be determined as a separate area.
   C. For purposes of compliance with Section 140.6(c)2, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in Table 146.0-C.
   D. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in primary function area.
   E. If at the time of permitting for a newly constructed building, a tenant is not identified for a multitenant area, a maximum of 0.4 watts per square foot shall be allowed for the lighting in each area in which a tenant has not been identified. The area shall be classified as unleased tenant area.
   F. Under the area category method, the allowed indoor lighting power for each primary function area is the lighting power density value in Table 140.6-C times the square feet of the primary function area. The total allowed indoor lighting power density for the building is the sum of all allowed indoor lighting powers densities for all areas in the building.
   G. In addition to the allowed indoor lighting power calculated according to Sections 140.6(c)2A through F, the building may add additional lighting power allowances for qualifying lighting systems as specified in the Qualifying Lighting Systems column in Table 140.6-C under the following conditions:
      i. Only primary function areas having a lighting system as specified in the Qualifying Lighting Systems column in Table 140.6-C and in accordance with the corresponding footnote of the table shall qualify for the additional lighting power allowances; and
      ii. The additional lighting power allowances shall be used only if the plans clearly identify all applicable task areas and the lighting equipment designed to illuminate these tasks; and
      iii. Tasks that are performed less than two hours per day or poor quality tasks that can be improved are not eligible for the additional lighting power allowances; and
      iv. The additional lighting power allowances shall not utilize any type of luminaires that are used for general lighting in the building; and
      v. The additional lighting power allowances shall not be used when using the complete building method; and
      vi. The additional lighting power allowed is the smaller of:
         a. the lighting power density listed in the "Allowed Additional Lighting LPD" column in Table 140.6-C, times the square feet of the primary function, or
         b. the adjusted indoor lighting power of the applicable lighting; and

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vii. In addition to meeting Sections 140.6(c)2Gi through vi, additional lighting power for videoconferencing as specified in Table 140.6-C shall be allowed in a videoconferencing studio, as defined in Section 100.1, provided the following conditions are met:

a. A completed and signed installation certificate is prepared and submitted in accordance with Section 130.4(b), specifically detailing compliance with the applicable requirements of Section 140.6(c)2Gvii; and

b. The videoconferencing studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites; and

c. General lighting is switched in accordance with the requirements of Section 130.1(b); and

d. Wall wash lighting is separately switched from the general lighting system; and

e. All of the lighting in the studio, including general lighting and additional lighting power allowed by Section 140.6(c)2Gvii is controlled by a multiscene programmable control system (also known as a scene preset control system).

viii. Floor displays shall not qualify for wall display allowances.

ix. Qualifying wall lighting shall:

a. Be mounted within 10 feet of the wall having the wall display. When track lighting is used for wall display, and where portions of that lighting track are more than 10 feet from the wall and other portions are within 10 feet of the wall, portions of track more than 10 feet from the wall shall not be used for the wall display allowance; and

b. Be a lighting system type appropriate for wall lighting. Lighting systems appropriate for wall lighting are lighting track adjacent to the wall, wall-washer luminaires, luminaires behind a wall valance or wall cove, or accent light. (Accent luminaires are adjustable or fixed luminaires providing directional display light.)

x. Additional allowed power for wall display lighting is available only for lighting that illuminates walls having wall displays. The length of display walls shall include the length of the perimeter walls, including but not limited to closable openings and permanent full-height interior partitions. Permanent full-height interior partitions are those that (I) extend from the floor to within 2 feet of the ceiling or are taller than 10 feet and (II) are permanently anchored to the floor.

xi. Mounting height shall be the luminaire mounting height measured from the finished floor to the bottom of the luminaire. If luminaires are mounted at different mounting heights within the same space, the average mounting height of the luminaires qualified for the additional lighting power allowances in Table 140.6-C can be used to establish the mounting height of the qualified luminaires for calculations of the additional lighting power allowances of the qualified luminaires.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.7—PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

(a) An outdoor lighting installation complies with this section if it meets the requirements in Subsections (b) and (c), and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated according to outdoor lighting zone in Title 24, Part 1, Section 10-114.

Exceptions to Section 140.7(a): When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall not be required to comply with Section 140.7:

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways, and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children's playgrounds.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.
6. Lighting of public monuments.
7. Lighting of signs complying with the requirements of Sections 130.3 and 140.8.
8. Lighting of tunnels, bridges, stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
9. Landscape lighting.
10. In theme parks: outdoor lighting only for themes and special effects.
11. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.

12. Outdoor lighting systems for qualified historic buildings, as defined in the *California Historic Building Code* (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 140.7.

(b) **Outdoor lighting power trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to Section 140.7(d)1 for general hardscape lighting allowance may be traded to specific applications in Section 140.7(d)2, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 140.7(d)1A.
2. Allowed lighting power determined according to Section 140.7(d)2 for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 140.7(d)1.
3. Trading of lighting power allowances between outdoor and indoor areas shall not be permitted.

(c) **Calculation of actual lighting power.** The wattage of outdoor luminaires shall be determined in accordance with Section 130.0(c).

(d) **Calculation of allowed lighting power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 140.7(d)1, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 140.7(d)2.

1. **General hardscape lighting allowance.** Determine the general hardscape lighting power allowances as follows:
   A. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s), and other improved area(s) that are illuminated. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the area wattage allowance (AWA) from Table 140.7-A for the appropriate lighting zone.

TABLE 140.7-A—GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

TYPE OF POWER ALLOWANCE	LIGHTING ZONE 0[3]	LIGHTING ZONE 1[3]	LIGHTING ZONE 2[3]	LIGHTING ZONE 3[3]	LIGHTING ZONE 4[3]
Area wattage allowance (AWA)	No allowance[1]	0.016 W/ft^2	0.019 W/ft^2	0.021 W/ft^2	0.024 W/ft^2
Linear wattage allowance (LWA)	No allowance[1]	0.13 W/lf	0.15 W/lf	0.20 W/lf	0.29 W/lf
Initial wattage allowance (IWA)	No allowance[1]	150 W	200 W	250 W	320 W

1. Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse or toilet facility; as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 130.2(b).
2. Reserved.
3. Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm—as mandated by local, state or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna—shall be allowed a 2.0 lighting power allowance multiplier.

   B. Determine the perimeter length of the general hardscape area. The total perimeter shall not include portions of hardscape that are not illuminated according to Section 140.7(d)1A. Multiply the hardscape perimeter by the linear wattage allowance (LWA) for hardscape from Table 140.7-A for the appropriate lighting zone. The perimeter length for hardscape around landscaped areas and permanent planters shall be determined as follows:
      i. Landscaped areas completely enclosed within the hardscape area, and which have a width or length less than 10 feet wide, shall not be added to the hardscape perimeter length.
      ii. Landscaped areas completely enclosed within the hardscape area, and which width or length is a minimum of 10 feet wide, the perimeter of the landscaped areas or permanent planter shall be added to the hardscape perimeter length.
      iii. Landscaped edges that are not abutting the hardscape shall not be added to the hardscape perimeter length.
   C. Determine the initial wattage allowance (IWA) for general hardscape lighting from Table 140.7-A for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.
   D. The general hardscape lighting allowance shall be the sum of the allowed watts determined from (A), (B) and (C) above.
2. **Additional lighting power allowance for specific applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with Table 140.7-B for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

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TABLE 140.7-B—ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.
PER APPLICATION: WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.

LIGHTING APPLICATION	LIGHTING ZONE 0	LIGHTING ZONE 1	LIGHTING ZONE 2	LIGHTING ZONE 3	LIGHTING ZONE 4
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
Building entrances or exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not applicable	9 watts	15 watts	19 watts	21 watts
Primary entrances to senior care facilities, police stations, healthcare facilities, fire stations and emergency vehicle facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not applicable	20 watts	40 watts	57 watts	60 watts
Drive up windows. Allowance per customer service location. Luminaires qualifying for this allowance shall be within two mounting heights of the sill of the window.	Not applicable	16 watts	30 watts	50 watts	75 watts
Vehicle service station uncovered fuel dispenser. Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within two mounting heights of the dispenser.	Not applicable	55 watts	77 watts	81 watts	135 watts
ATM lighting. Allowance per ATM. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not applicable	100 watts for first ATM, 35 watts for each additional ATM.			
PER APPLICATION: WATTAGE ALLOWANCE PER UNIT LENGTH (W/linear ft). May be used for one or two frontage side(s) per site.					
Outdoor sales frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides, provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not applicable	No Allowance	11 W/linear ft	19 W/linear ft	25 W/linear ft
PER APPLICATION: WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft^2). May be used for any illuminated hardscape area on the site.					
Hardscape ornamental lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 50 watts or less as determined in accordance with Section 130.0(c), and shall be post-top luminaires, lanterns, pendant luminaires or chandeliers.	Not applicable	No Allowance	0.007 W/ft^2	0.013 W/ft^2	0.019 W/ft^2
PER APPLICATION: WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft^2). **Use as appropriate, provided that none of the following specific applications shall be used for the same area.**					
Building facades. Only areas of building facade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the facade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not applicable	No Allowance	0.100 W/ft^2	0.170 W/ft^2	0.225 W/ft^2
Outdoor sales lots. Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other nonsales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within five mounting heights of the sales lot area.	Not applicable	0.060 W/ft^2	0.210 W/ft^2	0.280 W/ft^2	0.485 W/ft^2
Vehicle service station hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines or obstructed by a sign or other structure.	Not applicable	0.006 W/ft^2	0.068 W/ft^2	0.138 W/ft^2	0.200 W/ft^2
Vehicle service station canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	0.220 W/ft^2	0.430 W/ft^2	0.580 W/ft^2	1.010 W/ft^2
Sales canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	No Allowance	0.470 W/ft^2	0.622 W/ft^2	0.740 W/ft^2
Nonsales canopies and tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not applicable	0.057 W/ft^2	0.137 W/ft^2	0.270 W/ft^2	0.370 W/ft^2
Guard stations. Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates and vehicle contents. Qualifying luminaires shall be within two mounting heights of a vehicle lane or the guardhouse.	Not applicable	0.081 W/ft^2	0.176 W/ft^2	0.325 W/ft^2	0.425 W/ft^2
Student pick-up/drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within two mounting heights of the student pick-up/drop-off zone.	Not applicable	No Allowance	0.056 W/ft^2	0.200 W/ft^2	No Allowance
Outdoor dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within two mounting heights of the hardscape area of outdoor dining.	Not applicable	0.004 W/ft^2	0.030 W/ft^2	0.050 W/ft^2	0.075 W/ft^2
PER SITE: WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft^2). **May be used as additional allowance for applicable illuminated hardscape area on the site.**					
Special security lighting for retail parking and pedestrian hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft^2	0.005 W/ft^2	0.010 W/ft^2	No Allowance
Security cameras. This additional allowance is for illuminated general hardscape area. This allowance shall apply when a security camera is installed within 2 mounting heights of the general hardscape area and mounted more than 10 feet away from a building.	Not applicable	No allowance	0.018 W/ft^2	0.018 W/ft^2	0.018 W/ft^2

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SECTION 140.8—PRESCRIPTIVE REQUIREMENTS FOR SIGNS

This section applies to all internally illuminated and externally illuminated signs, unfiltered light emitting diodes (LEDs) and unfiltered neon, both indoor and outdoor. Each sign shall comply with either Subsection (a) or (b), as applicable.

(a) **Maximum allowed lighting power.**

1. For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 12 watts per square foot. For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power.
2. For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 2.3 watts per square foot. Only areas of an externally lighted sign that are illuminated without obstruction or interference, by one or more luminaires, shall be used.
3. Lighting for unfiltered light emitting diodes (LEDs) and unfiltered neon shall comply with Section 140.8(b).

(b) **Alternate lighting sources.** The sign shall be equipped with one or more of the following light sources:

1. Reserved.
2. Reserved.
3. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to the following:
   A. A minimum efficiency of 75 percent when the transformer or power supply rated output current is less than 50 mA; or
   B. A minimum efficiency of 68 percent when the transformer or power supply rated output current is 50 mA or greater.

   The ratio of the output wattage to the input wattage is at 100 percent tubing load.
4. Reserved.
5. Light emitting diodes (LEDs) with a power supply having an efficiency of 80 percent or greater; or

   Exception to Section 140.8(b)5: Single voltage external power supplies that are designed to convert 120 volt AC input into lower voltage DC or AC output, and have a nameplate output power less than or equal to 250 watts, shall comply with the applicable requirements of the appliance efficiency regulations (Title 20).

Exception 1 to Section 140.8: Unfiltered incandescent lamps that are not part of an electronic message center (EMC), an internally illuminated sign or an externally illuminated sign.

Exception 2 to Section 140.8: Exit signs. Exit signs shall meet the requirements of the appliance efficiency regulations.

Exception 3 to Section 140.8: Traffic Signs. Traffic signs shall meet the requirements of the appliance efficiency regulations.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 140.9—PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

(a) **Prescriptive requirements for computer rooms.** Computer rooms with a power density greater than 20 W/ft^2 shall comply with this section.

1. **Economizers.** Each individual cooling system primarily serving computer room shall include either:
   A. An integrated air economizer capable of providing partial cooling even when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 65°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i); or
   B. An integrated water economizer capable of providing partial cooling even when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 50°F dry-bulb and below or 45°F wet-bulb and below.

   Exception 1 to Section 140.9(a)1: Individual computer rooms with an ITE design load under 5 tons (18 kW) in a building that does not have any economizers.

   Exception 2 to Section 140.9(a)1: A computer room with an ITE design load less than 20 tons (70 kW) may be served by a second fan system without an economizer if it is also served by a fan system with an economizer that also serves other spaces within the building, provided that all of the following are met:
      i. The economizer system is sized to meet the design cooling load of the computer room when the other spaces within the building are at 50 percent of their design load at outside air temperatures of 65°F dry-bulb and below or 50°F wet-bulb and below; and
      ii. An economizer system that can stop service to other spaces in the building when those spaces are unoccupied and serve only the computer rooms.
2. **Power consumption of fans.** The total fan power at design conditions of each fan system shall not exceed 27 W/kBtu·h of net sensible cooling capacity.
3. **Air containment.** Computer rooms with air-cooled computers in racks and with an ITE design load exceeding 10 kW (2.8 tons) per room shall include air barriers such that there is no significant air path for computer discharge air to recirculate back to computer inlets without passing through a cooling system.

   Exception 1 to Section 140.9(a)3: Expansions of existing computer rooms.

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Exception 2 to Section 140.9(a)3: Computer racks with a design load less than 1 kW (0.28 tons) per rack.

Exception 3 to Section 140.9(a)3: Equivalent energy performance based on computational fluid dynamics or other analysis.

4. **Alternating current-output uninterruptible power supplies (UPS).** Alternating current-output UPS systems serving a computer room shall meet or exceed minimum average efficiencies in Table 140.9-B. Minimum average efficiency for alternating current-output UPS shall meet or exceed calculation and testing requirements identified in ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) – Eligibility Criteria Version 2.0.

   where:

   P is the rated output power in watts (W).

   E_{MOD} is an allowance of 0.004 for modular UPSs applicable in the commercial 1,500–10,000 W range.

   ln is the natural logarithm.

   The requirement shall be rounded to the third decimal place for certification and reporting.

   Exception to Section 140.9(a)4: Alternating current-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in ANSI/NEMA WD-6-2016.

TABLE 140.9-B—ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY MINIMUM AVERAGE EFFICIENCY

	VOLTAGE AND FREQUENCY DEPENDENT	VOLTAGE INDEPENDENT	VOLTAGE AND FREQUENCY INDEPENDENT
$P < 350$ W	$5.71 \times 10^{-5} \times P + 0.962$	$5.71 \times 10^{-5} \times P + 0.964$	$0.011 \times \ln(P) + 0.824$
350 W < P <1,500 W	0.982	0.984	$0.011 \times \ln(P) + 0.824$
1,500 W < P <10,000 W	$0.981 - E_{MOD}$	$0.980 - E_{MOD}$	$0.0145 \times \ln(P) + 0.800 - E_{MOD}$
P >10,000 W	0.970	0.940	$0.0058 \times \ln(P) + 0.886$

(b) **Prescriptive requirements for commercial kitchens.**

1. **Kitchen exhaust systems.**
   A. Replacement air introduced directly into the hood cavity of kitchen exhaust hoods shall not exceed 10 percent of the hood exhaust airflow rate.
   B. For kitchen/dining facilities having total Type I and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, each Type I hood shall have an exhaust rate that complies with Table 140.9-C. If a single hood or hood section is installed over appliances with different duty ratings, then the maximum allowable flow rate for the hood or hood section shall not exceed the Table 140.9-C values for the highest appliance duty rating under the hood or hood section. Refer to ASHRAE Standard 154-2011 for definitions of hood type, appliance duty and next exhaust flow rate.

      Exception 1 to Section 140.9(b)1B: 75 percent of the total Type I and Type II exhaust replacement air is transfer air that would otherwise be exhausted.

      Exception 2 to Section 140.9(b)1B: Existing hoods not being replaced as part of an addition or alteration.

TABLE 140.9-C—MAXIMUM NET EXHAUST FLOW RATE, CFM PER LINEAR FOOT OF HOOD LENGTH

TYPE OF HOOD	LIGHT DUTY EQUIPMENT	MEDIUM DUTY EQUIPMENT	HEAVY DUTY EQUIPMENT	EXTRA HEAVY DUTY EQUIPMENT
Wall-mounted canopy	140	210	280	385
Single island	280	350	420	490
Double island	175	210	280	385
Eyebrow	175	175	Not allowed	Not allowed
Backshelf/passover	210	210	280	Not allowed

2. **Kitchen ventilation.**
   A. Mechanically cooled or heated makeup air delivered to any space with a kitchen hood shall not exceed the greater of:
      i. The supply flow required to meet the space heating and cooling load; or
      ii. The hood exhaust flow minus the available transfer air from adjacent spaces. Available transfer air is that portion of outdoor ventilation air serving adjacent spaces not required to satisfy other exhaust needs, such as restrooms, not required to maintain pressurization of adjacent spaces, and that would otherwise be relieved from the building.

   Exception to Section 140.9(b)2A: Existing kitchen makeup air units not being replaced as part of an addition or alteration.

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B. A kitchen/dining facility having a total Type I and Type II kitchen hood exhaust airflow rate greater than 5,000 cfm shall have one of the following:
   i. At least 50 percent of all replacement air is transfer air that would otherwise be exhausted; or
   ii. Demand ventilation system(s) on at least 75 percent of the exhaust air. Such systems shall:
      a. Include controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle; and
      b. Include failsafe controls that result in full flow upon cooking sensor failure; and
      c. Include an adjustable timed override to allow occupants the ability to temporarily override the system to full flow; and
      d. Be capable of reducing exhaust and replacement air system airflow rates to the larger of:
         (i) 50 percent of the total design exhaust and replacement air system airflow rates; or
         (ii) The ventilation rate required as specified by Section 120.1(c)3.
   iii. Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on at least 50 percent of the total exhaust airflow; or
   iv. A minimum of 75 percent of makeup air volume that is:
      a. Unheated or heated to no more than 60°F; and
      b. Uncooled or cooled without the use of mechanical cooling.

Exception to Section 140.9(b)2B: Existing hoods not being replaced as part of an addition or alteration.

3. **Kitchen exhaust system acceptance.** Before an occupancy permit is granted for a commercial kitchen subject to Section 140.9(b), the following equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the Reference Nonresidential Appendix NA7. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.11.

Exception to Section 140.9(b): Healthcare facilities.

(c) **Prescriptive requirements for laboratory and factory exhaust systems.**

1. **Airflow reduction requirements.** Building laboratory exhaust systems shall be able to reduce zone exhaust and makeup airflow rates to the occupied and unoccupied minimum exhaust airflow rates based on demand and sensed occupancy as follows:
   A. Occupied minimum exhaust airflow. When occupant sensing controls sense occupants in the space, the minimum exhaust and makeup airflow rates shall be the greater of:
      i. User-defined airflow not to exceed 1.0 cfm/ft^2 (equivalent to 6 air changes per hour for a 10-foot high ceiling); or
      ii. The regulated minimum occupied circulation rate documented to comply with code, accreditation, or facility environmental health and safety department requirements; or
      iii. The minimum needed to maintain occupied pressurization.
   B. Unoccupied minimum exhaust airflow. Within 20 minutes of no occupancy being detected by any occupant sensors covering the space, the minimum exhaust and makeup airflow rates shall be the greater of:
      i. User-defined airflow not to exceed 0.67 cfm/ft^2 (equivalent to 4 air changes per hours for a 10-foot high ceiling); or
      ii. The regulated minimum unoccupied circulation rate documented to comply with code, accreditation, or facility environmental health and safety department requirements; or
      iii. The minimum needed to maintain unoccupied pressurization.
   C. Applicable equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the reference Nonresidential Appendix NA7.16. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in Nonresidential Appendix NA7.16.

Exception to Section 140.9(c)1: New zones on an existing constant volume exhaust system.

2. **Exhaust System Transfer Air.** Conditioned supply air delivered to any space with mechanical exhaust shall comply with the requirements of Section 140.4(o).
3. **Fan System Power Consumption.** All newly installed fan exhaust systems serving a laboratory or factory with a design exhaust fan system airflow rate greater than 10,000 cfm shall meet Subsection A and either B, C, or D. Exhaust air in laboratories or factories includes all indoor air and gases removed by the exhaust system, including exhaust air from fume hoods, hazardous exhaust flows, or other manifolded exhaust streams. Exhaust fan system airflow rate is the total of the airflow rates entering the exhaust fans, which includes exhaust air and bypass air but does not include entrained or induced airflow downstream of the exhaust fans.
   A. Systems serving laboratory spaces shall meet all discharge requirements in ANSI Z9.5-2022, Section 6.4.
   B. The exhaust fan system electrical input power (Fan $kW_{design,system}$) determined per Section 140.4(c)1B at the fan system design airflow does not exceed Fan kW_{budget} as calculated per Section 140.4(c)1A.

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C. The exhaust fan system power shall not exceed 0.85 watts per cfm of exhaust fan system airflow for systems with air filtration, scrubbers, or other air treatment devices. For all other exhaust fan systems the system power shall not exceed 0.65 watts per cfm of exhaust fan system airflow. Exhaust fan system power equals the sum of the power of all fans in the exhaust system that are required to operate at normal occupied design conditions in order to exhaust air from the conditioned space to the outdoors.

D. The exhaust fan system shall comply with all of the following:

i. The sum of the occupied minimum circulation rates of the spaces served by the fan system shall be less than 60 percent of the exhaust fan system design airflow rate.

ii. The design exhaust fan system power shall not exceed 1.3 watts per cfm of exhaust fan system airflow when operating under full-load design conditions.

iii. The system shall include variable speed controls so that exhaust system fans shall draw no more than 40 percent of the design fan power when the exhaust fan system airflow is 60 percent of the design airflow rate.

iv. The exhaust fan system airflow rate shall not exceed the larger of:

a. The sum of the space exhaust airflow rates served by the system; or

b. The minimum acceptable exhaust fan system airflow rate.

v. The minimum acceptable exhaust airflow rate, using the procedures and system definitions included in ANSI Z9.5 (2022) Appendix 3, shall be one of the following:

a. Less than 60 percent of the exhaust fan system design airflow rate (simple turndown control system); or

b. Dynamically reset based on measured wind speed and/or wind direction and assumes worst-case emissions rate and shall be less than 60 percent of the exhaust fan system design airflow rate for at least 70 percent of the hours during a typical meteorological year (TY) for the site (wind responsive control system); or

c. Dynamically reset based on measured contaminant concentration and shall be less than 60 percent of the exhaust fan system design airflow rate when measured contaminants in the exhaust system plenum are below the threshold contaminant concentration value (monitored control system).

vi. Exhaust system design and control results in calculated outdoor contaminant concentrations in compliance with applicable federal, state, or local regulations.

vii. Applicable equipment and systems shall be certified as meeting the acceptance requirements for code compliance, as specified by the reference Nonresidential Appendix NA7.16. A certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in Nonresidential Appendix NA7.16.

4. **Fume Hood Automatic Sash Closure.** Variable air volume laboratory fume hoods with vertical only sashes located in fume hood intensive laboratories, as described in Table 140.9-D, shall have an automatic sash closure system that complies with the following:

A. The automatic sash closure system shall be capable of the following:

i. The automatic sash closure system shall have a dedicated zone presence sensor that detects people in the area near the fume hood sash and automatically closes the sash within 5 minutes of no detection.

ii. The automatic sash closure system shall have controls to prevent the sash from automatic closing when a force of no more than 10 lbs is detected.

iii. The automatic sash closure system shall be equipped with an obstruction sensor that prevents the sash from automatic closing with obstructions in the sash opening. Obstruction sensor shall be capable of sensing transparent materials such as laboratory glassware.

iv. The automatic sash closure system shall be capable of being configured in a manual open mode where once the sash is closed, detection of people in the area near the fume hood by the zone presence sensor does not open the fume hood sash.

B. Fume Hood Automatic Sash Closure Acceptance. Before an occupancy permit is granted for the fume hoods subject to 140.9(c)4, the equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.17.

TABLE 140.9-D—FUME HOOD INTENSIVE LABORATORIES THRESHOLD (both must be true)

Occupied minimum ventilation ACH	≤ 4	> 4 and ≤ 6	> 6 and ≤ 8	> 8 and ≤ 10	> 10 and ≤ 12	> 12 and ≤ 14
Hood density (linear feet per 10,000 ft^3 of laboratory space)	≥ 6	≥ 8	≥ 10	≥ 12	≥ 14	≥ 16

5. **Reheat limitation.** Air handlers in buildings with greater than 20,000 cfm of laboratory exhaust that serve multiple space-conditioning zones in laboratory spaces shall not mechanically cool air handler supply air below 80°F and shall not heat air

handler supply air above 50°F, and each zone shall include heating and cooling capacity to prevent cooling at the air handler and reheating at the zones.

Exception 1 to Section 140.9(c)5: Additions or alterations to existing air-handling systems serving existing zones without heating and cooling capacity.

Exception 2 to Section 140.9(c)5: Systems in Climate Zones 7 or 15.

Exception 3 to Section 140.9(c)5: Systems dedicated to vivarium spaces or to spaces classified as biosafety level 3 or higher.

Exception 4 to Section 140.9(c)5: Systems that:

1. Are located where the outdoor dew point temperature is greater than or equal to 64°F at the ASHRAE 2 percent annual dehumidification design condition; and
2. Include heating and cooling capacity at each zone; and
3. Do not mechanically cool air handler supply air below 80°F when the outdoor dew point temperature is below 60°F.

6. **Exhaust air heat recovery.** Buildings with greater than 10,000 cfm of laboratory exhaust shall include an exhaust air heat recovery system that meets the following:
   A. A sensible energy recovery ratio of at least 45 percent at heating design conditions and 25 percent at cooling design conditions.
   B. Heat is recovered from at least 75 percent of all lab exhaust air volume.
   C. The system includes a run-around coil pump or other means to disable heat recovery.
   D. The system includes a bypass damper or other means so that the exhaust air pressure drop through the heat exchanger does not exceed 0.4 inch w.g. when heat recovery is disabled.

Exception 1 to Section 140.9(c)6: Additions or alterations to existing laboratory exhaust systems that do not include exhaust air heat recovery.

Exception 2 to Section 140.9(c)6: Buildings where the total laboratory exhaust rate exceeds 20 cfm/ft^2 of roof area.

Exception 3 to Section 140.9(c)6: Locations that meet both of the following:

1. In Climate Zone 6 or 7; and
2. In a jurisdiction where gas heating is allowed.

Exception 4 to Section 140.9(c)6: Buildings with an exhaust air heat recovery system and heat recovery chillers designed to provide at least 40 percent of the peak heating load from exhaust heat recovery.

Exception 5 to Section 140.9(c)6: Exhaust systems requiring wash down systems such as exhaust systems dedicated to perchloric acid fume hoods.

Exception to Section 140.9(c): Healthcare facilities.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8 and 25943, *Public Resources Code.*

SECTION 140.10—PRESCRIPTIVE REQUIREMENTS FOR PHOTOVOLTAIC AND BATTERY ENERGY STORAGE SYSTEMS

(a) **Photovoltaic requirements.** All newly constructed building types specified in Table 140.10-A, or mixed occupancy buildings where at least 80 percent of the floor area of the building serves one or more of these building types, shall have a newly installed photovoltaic (PV) system meeting the minimum qualification requirements of Reference Joint Appendix JA11. The PV capacity in kW_{dc} shall not be less than the smaller of the minimum rated PV system capacity determined by Equation 140.10-A, or the total of all available solar access roof areas (SARA) multiplied by 18 for steep-sloped roofs or multiplied by 14 for low-sloped roofs. In mixed occupancy buildings, the minimum rated PV system capacity for the building shall be determined by applying Equation 140.10-A to the conditioned floor area of each of the listed building types and summing the capacities determined for each.

1. SARA includes the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.10.
2. SARA does NOT include:
   A. Any area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation (accounting for shading obstructions) by the total annual solar insolation if the same areas were unshaded by those obstructions. For all roofs, all obstructions, including those that are external to the building, and obstructions that are part of the building design and elevation features may be considered for the annual solar access calculations.
   B. Occupied roofs as specified by CBC Section 503.1.4.
   C. Roof area that is otherwise not available due to compliance with:
      i. Other state building code requirements; or
      ii. Local building code requirements if the local building code requirements are confirmed by the Executive Director.

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EQUATION 140.10-A—PHOTOVOLTAIC DIRECT CURRENT CAPACITY

$kW_{PVdc} = (CFA \times A)/1000$

where:

kW_{PVdc} = Minimum rated PV system capacity in kW.

CFA = Conditioned floor area in square feet.

A = PV capacity factor in W/square foot as specified in Table 140.10-A for the building type.

Exception 1 to Section 140.10(a): No PV system is required where the total of all available SARA is less than 3 percent of the conditioned floor area.

Exception 2 to Section 140.10(a): No PV system is required where the required PV system capacity is less than 4 kW_{dc}.

Exception 3 to Section 140.10(a): No PV system is required if the SARA contains less than 80 contiguous square feet.

Exception 4 to Section 140.10(a): Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules, components, supports and attachments to the roof structure, to meet ASCE 7-16, Chapter 7, Snow Loads.

Exception 5 to Section 140.10(a): For nonresidential and hotel/motel multitenant buildings, the PV capacity determined by Equation 140.10-A shall be calculated without including tenant spaces meeting all of the following:

i. The tenant space is less than or equal to 2,000 square feet of conditioned space;
ii. The tenant space is served by an HVAC system that does not serve other tenant spaces in the building; and
iii. The tenant space has an individual utility meter to track electricity consumption that does not include the electricity consumption of other tenant spaces in the building.

This exception does not apply where the Commission has approved a community solar program for showing compliance as specified in Title 24, Part 1, Section 10-115, or where a load-serving entity provides a program where PV generation is compensated through virtual energy bill credits for occupants of nonresidential and hotel/motel tenant spaces to receive energy bill benefits from netting of energy generation and consumption.

(b) **Battery energy storage system (BESS) requirements.** All buildings that are required by Section 140.10(a) to have a PV system shall also have a BESS meeting the minimum qualification requirements of Reference Joint Appendix JA12. The rated energy capacity shall be not less than the Minimum Rated Useable Energy Capacity determined using Equation 140.10-B or 140.10-C if SARA was used to determine the PV capacity in Section 140.10(a). The rated power capacity shall be not less than the Minimum Power Capacity determined using Equation 140.10-D. In mixed occupancy buildings, the total battery system capacity for the building shall be determined by applying the Minimum Rated Usable Energy Capacity to each of the listed building types and summing the capacities determined for each.

EQUATION 140.10-B—BATTERY ENERGY STORAGE SYSTEM MINIMUM RATED USABLE ENERGY CAPACITY

$kWh_{batt} = [(CFA \times B)/(1{,}000 \times C^{0.5})]$

EQUATION 140.10-C—BATTERY ENERGY STORAGE SYSTEM MINIMUM RATED USABLE ENERGY CAPACITY, SARA-ADJUSTED

$kWh_{batt} = [(CFA \times B)/(1{,}000 \times C^{0.5})] \times (kW_{PVdc,SARA}/kW_{PVdc})$

where:

kWh_{batt}= Minimum Rated Usable Energy Capacity of the BESS in kWh.

CFA = Conditioned floor area that is subject to the PV system requirements of Section 140.10(a) in square feet.

kW_{PVdc} = Minimum Rated PV System Capacity in kW from Equation 140.10-A.

$kW_{PVdc, SARA}$ = Minimum Rated PV System Capacity in kW from the SARA calculation.

B = BESS Capacity Factor in Wh/square foot as specified in Table 140.10-B for the building type.

C = Rated single charge-discharge cycle AC to AC (round-trip) efficiency of the BESS.

EQUATION 140.10-D—BESS MINIMUM RATED POWER CAPACITY

$kW_{batt} = kW_{batt}/4$

where:

kW_{batt} = Minimum Rated Power Capacity of the BESS in kWdc.

kW_{PVdc} = Minimum Rated Useable Energy Capacity of the BESS in kWh.

Exception 1 to Section 140.10(b): No BESS is required if the installed PV system capacity is less than 15 percent of the capacity determined by Equation 140.10-A.

Exception 2 to Section 140.10(b): No BESS is required if the rated usable energy capacity determined by Equation 140.10-B or Equation 140.10-C is less than 10 kWh.

Exception 3 to Section 140.10(b): For multitenant buildings, the energy capacity of the BESS shall be based on the tenant spaces with more than 5,000 square feet of conditioned floor area. For single-tenant buildings with less than 5,000 square feet of conditioned floor area, no BESS is required.

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TABLE 140.10-A—PV CAPACITY FACTORS (W/ft² of conditioned floor area)																
BUILDING TYPE	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Events & Exhibits	3.48	4.28	3.66	4.32	3.77	4.05	4.28	4.83	4.63	4.80	5.04	4.44	4.95	4.36	5.48	3.38
Library	0.39	3.23	2.59	3.25	2.48	2.74	3.04	3.49	3.32	3.69	3.79	3.32	3.79	3.37	4.49	2.84
Hotel/Motel	1.69	1.90	1.66	1.97	1.69	1.87	1.94	2.22	2.09	2.20	2.30	2.05	2.30	2.02	2.72	1.73
Office, Financial Institution, Unleased Tenant Space, Medical Office Building/Clinic	2.59	3.13	2.59	3.13	2.59	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.80	2.59
Restaurants	8.55	9.32	8.16	9.65	8.21	8.73	9.11	10.18	9.75	10.28	10.85	9.73	10.69	9.73	12.25	8.47
Retail, Grocery	3.14	3.49	3.01	3.61	3.05	3.27	3.45	3.83	3.65	3.81	4.09	3.64	3.99	3.71	4.60	3.21
School	1.27	1.63	1.27	1.63	1.27	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	2.46	1.27
Warehouse	0.39	0.44	0.39	0.44	0.39	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.58	0.39
Religious Worship	4.25	4.65	3.49	4.52	3.72	4.29	4.64	5.89	5.30	5.67	5.89	4.99	5.78	4.63	7.57	3.90
Sports & Recreation	2.47	1.97	1.54	2.03	1.60	1.84	1.98	2.63	2.47	2.60	2.75	2.20	2.72	2.15	4.03	1.81
Multifamily > 3 stories	1.82	2.21	1.82	2.21	1.82	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.77	1.82

TABLE 140.10-B—BESS CAPACITY FACTORS (Wh/ft² of conditioned floor area)																
BUILDING TYPE	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Events & Exhibits	1.82	1.95	1.74	2.12	1.91	2.13	2.24	2.30	2.36	2.47	2.62	2.16	2.64	2.68	3.22	1.89
Library	0.37	7.17	5.97	6.75	5.64	6.08	6.19	7.13	7.18	7.56	7.17	6.93	6.88	6.81	7.93	6.40
Hotel/Motel	0.86	0.84	0.77	0.92	0.81	0.89	0.90	1.01	1.00	1.11	1.14	0.96	1.18	1.18	1.49	0.85
Office, Financial Institution, Unleased Tenant Space, Medical Office Building/Clinic	NR[1]	5.26	4.35	5.26	4.35	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	6.39	4.35
Restaurants	4.36	4.11	3.78	4.37	3.89	4.02	4.11	4.49	4.47	4.82	5.05	4.43	5.05	5.24	6.23	4.11
Retail, Grocery	1.89	1.82	1.71	1.82	1.72	1.80	1.76	1.92	1.97	2.05	2.22	1.95	2.16	2.29	2.66	1.91
School	NR[1]	3.05	2.38	3.05	2.38	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	4.60	2.38
Warehouse	NR[1]	0.41	0.37	0.41	0.37	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.54	0.37
Religious Worship	2.21	2.25	1.74	2.42	2.08	2.75	2.94	3.37	3.17	3.37	3.58	2.72	3.62	3.21	4.89	2.37
Sports & Recreation	1.26	0.98	0.76	1.14	0.86	1.20	1.23	1.57	1.53	1.65	1.83	1.27	1.86	1.57	3.02	1.13
Multifamily > 3 stories	1.88	2.27	1.88	2.27	1.88	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.85	1.88

1. NR = Not Required.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8 and 25943, *Public Resources Code*.

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SUBCHAPTER

6

NONRESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—ADDITIONS, ALTERATIONS AND REPAIRS

SECTION 141.0—ADDITIONS, ALTERATIONS AND REPAIRS TO EXISTING NONRESIDENTIAL AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

Additions, alterations, and repairs to existing nonresidential and hotel/motel buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs, shall meet the requirements specified in Sections 100.0 through 110.12, and 120.0 through 130.5 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 141.0(a)2 (for additions) or 141.0(b) 3 (for alterations), or the prescriptive compliance approach in Section 141.0(a)1 (for additions) or 141.0(b)2 (for alterations), for the Climate Zone in which the building is located. Climate zones are shown in Figure 100.1-A.

Covered process requirements for additions, alterations and repairs to existing nonresidential and hotel/motel buildings are specified in Section 141.1.

Exception to Section 141.0: Alterations to healthcare facilities are not required to comply with this Section.

NOTES:

1. For alterations that change the occupancy classification of the building, the requirements specified in Section 141.0(b) apply to the occupancy after the alterations.
2. Relocation or moving of a relocatable public school building is not, by itself, considered an alteration for the purposes of Title 24, Part 6.

(a) **Additions.** Additions shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The envelope and lighting of the addition, any newly installed space-conditioning system, electrical power distribution system, or water-heating system; any addition to an outdoor lighting system; and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110.0 through 120.7, 120.9 through 130.5 and 140.2 through 140.9.
2. **Performance approach.**
   A. The envelope and indoor lighting in the conditioned space of the addition, and any newly installed space-conditioning system, electrical power distribution system, or water-heating system, shall meet the applicable requirements of Sections 110.0 through 120.7, 120.9 through 130.5; and
   B. Either:
      i. The addition alone shall comply with Section 140.1; or
      ii. Existing plus addition plus alteration. The standard design for existing plus addition, plus alteration energy use is the combination of the existing building's unaltered components to remain, existing building altered components that are the more efficient, in LSC, of either the existing conditions, or the requirements of Section 141.0(b)2, plus the proposed addition's energy use meeting the requirements of Section 140.1. The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered component's energy features, plus the proposed energy features of the addition.

Exception 1 to Section 141.0(a): When heating, cooling or service water heating to an addition are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 120.9 or Sections 140.4 through 140.5.

Exception 2 to Section 141.0(a): Where an existing system with electric reheat is expanded by adding variable air volume (VAV) boxes to serve an addition, total electric reheat capacity may be expanded so that the total capacity does not exceed 150 percent of the existing installed electric heating capacity in any one permit, and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 150 percent of the existing installed electric heating capacity may be added subject to the requirements of Section 140.4(g).

Exception 3 to Section 141.0(a): Duct sealing. When ducts are extended from an existing duct system to serve the addition, the existing duct system and the extended ducts shall meet the applicable requirements specified in Section 141.0(b)2D.

Exception 4 to Section 141.0(a): Additions that increase the area of the roof by 2,000 square feet or less are not required to comply with Section 110.10.

Exception 5 to Section 141.0(a): A gas hot water boiler system with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h added to an existing building is not required to comply with Section 140.4(k)8.

Exception 6 to Section 141.0(a): A gas service water-heating system with a total system input of at least 1 MMBtu/h added to an existing building is not required to comply with Section 140.5(c).

Exception 7 to Section 141.0(a): Section 140.4(a)2 shall not apply to new space-conditioning systems or components.

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(b) **Alterations.** Alterations to components of existing nonresidential, hotel/motel, or relocatable public school buildings, including alterations made in conjunction with a change in building occupancy to a nonresidential, high-rise residential or hotel/motel occupancy shall meet Item 1, and either Item 2 or 3 below:

1. **Mandatory requirements.** Altered components in a nonresidential or hotel/motel building shall meet the minimum requirements in this section.
   A. **Roof/ceiling insulation.** The opaque portions of the roof/ceiling that separate conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Section 141.0(b)2Bii.
   B. **Wall insulation.** For the altered opaque portion of walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 4 below:
      1. **Metal building.** A minimum of R-13 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.113.
      2. **Metal framed.** A minimum of R-13 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.217.
      3. **Wood framed and others.** A minimum of R-11 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.110.
      4. **Spandrel panels and glass curtain walls.** A minimum of R-4, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.280.

      Exception to Section 141.0(b)1B: Light and heavy mass walls.
   C. **Floor insulation.** For the altered portion of raised floors that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:
      1. **Raised framed floors.** A minimum of R-11 insulation between framing members, or the area-weighted average *U*-factor of the floor assembly shall not exceed the *U*-factor of U-0.071.
      2. **Raised mass floors in hotel/motel guest rooms.** A minimum of R-6 insulation, or the area-weighted average *U*-factor of the floor assembly shall not exceed the *U*-factor of U-0.111.
      3. **Raised mass floors in other occupancies.** No minimum *U*-factor requirement.
   D. **Fan energy index:** New fan systems serving an existing building shall meet the requirements of Section 120.10.
   E. **Exterior windows.** Fenestration alterations other than repairs shall meet the following requirements:
      1. **Vertical fenestration alterations.** Where over 150 square feet of the entire building's vertical fenestration is replaced, the maximum *U*-factor of the replaced units shall not exceed U-0.58.
      2. **Added vertical fenestration.** Where over 50 square feet of vertical fenestration is added, it shall meet the requirements of Section 120.7(d). Where 50 square feet or less of vertical fenestration is added, this requirement shall not apply.
2. **Prescriptive approach.** The altered components of the envelope, or space conditioning, lighting, electrical power distribution and water heating systems, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5.

   Exception to Section 141.0(b)2: The requirements of Section 120.2(i) shall not apply to alterations of spaceconditioning systems or components.
   A. Fenestration alterations other than repair and those subject to Section 141.0(b)2 shall meet the requirements below:
      i. Vertical fenestration alterations shall meet the requirements in Table 141.0-A.
      ii. Added vertical fenestration shall meet the requirements of Table 140.3-B, C or D.
      iii. All altered or newly installed skylights shall meet the requirements of Table 140.3-B, C or D.

      Exception 1 to Section 141.0(b)2Ai: In an alteration, where 150 square feet or less of the entire building's vertical fenestration is replaced, RSHGC and VT requirements of Table 141.0-A shall not apply.

      Exception 2 to Section 141.0(b)2Aii: In an alteration, where 50 square feet or less of vertical fenestration is added, RSHGC and VT requirements of Table 140.3-B, C or D shall not apply.

      Exception 3 to Section 141.0(b)2Aiii: In an alteration, where 50 square feet or less of skylight is added, SHGC and VT requirements of Table 140.3-B, C or D shall not apply.

   NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs. In these cases, Section 141.0(c) requires that the replacement be at least equivalent to the original in performance.

TABLE 141.0-A—ALTERED VERTICAL FENESTRATION MAXIMUM *U*-FACTOR AND MAXIMUM RSHGC

CLIMATE ZONE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
***U*-factor**	0.47	0.47	0.58	0.47	0.58	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
RSHGC	0.41	0.31	0.41	0.31	0.41	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.41
VT	See Table 140.3-B, C and D for all climate zones.															

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B. Existing roofs of a nonresidential or hotel/motel building being replaced, recovered or recoated, as defined in Section 100.1(b) and Title 24, Part 2, Chapter 2, shall meet the requirements of Section 110.8(i). When roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, are being altered the requirements of i and ii apply:

i. Roofing products shall comply with requirements in Section 140.3(a)1A.

Exception 1 to Section 141.0(b)2Bi: An aged solar reflectance less than 0.63 is allowed for low-sloped roofs provided the maximum roof/ceiling *U*-factor in Table 141.0-B is not exceeded.

Exception 2 to Section 141.0(b)2Bi: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

Exception 3 to Section 141.0(b)2Bi: Roof constructions with a weight of at least 25 lb/ft^2 are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

TABLE 141.0-B—ROOF/CEILING INSULATION TRADEOFF FOR LOW-SLOPED AGED SOLAR REFLECTANCE

NONRESIDENTIAL		
Aged Solar Reflectance	**Climate Zones 6, 7 and 8 *U*-factor**	**All Other Climate Zones *U*-factor**
0.62–0.60	0.043	0.035
0.59–0.55	0.041	0.034
0.54–0.50	0.038	0.031
0.49–0.45	0.034	0.029
0.44–0.40	0.032	0.028
0.39–0.35	0.029	0.026
0.34–0.30	0.028	0.025
0.29–0.25	0.026	0.024

ii. **Roof/ceiling insulation.** For low-sloped roofs, the area of the roof recover or roof replacement shall be insulated to the level specified in Table 141.0-C.

Exception 1 to Section 141.0(b)2Bii: Roof recovers with new R-10 insulation added above deck do not need to be insulated to the level specified in Table 141.0-C.

Exception 2 to Section 141.0(b)2Bii: When existing mechanical equipment located on the roof will not be disconnected and lifted, insulation added is the greater of R-10 or the maximum installed thickness that will allow the distance between the height of the roof membrane surface and the top of the base flashing to remain in accordance with the manufacturer's instructions.

Exception 3 to Section 141.0(b)2Bii: At the drains and other low points, tapered insulation with a thermal resistance less than that prescribed in Table 141.0-C may be used, provided that insulation thickness is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value specified in Table 141.0-C.

Exception 4 to Section 141.0(b)2Bii: The area of the roof recoat is not required to be insulated.

TABLE 141.0-C—INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

CLIMATE ZONE	CONTINUOUS INSULATION *R*-VALUE	*U*-FACTOR
1–5, 9–16	R-23	0.037, with at least R-10 above deck
6–8	R-17	0.047, with at least R-10 above deck

C. **New or replacement space-conditioning systems or components** other than new or replacement space-conditioning system ducts shall meet the requirements of Section 140.4 applicable to the systems or components being altered and meet the following:

i. Additional fan power allowances are available when determining the fan power budget (Fan kW_{budget}) as specified in Table 141.0-D. These values can be added to the fan power allowance values in Table 140.4-A and Table 140.4-B.

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TABLE 141.0-D—ADDITIONAL FAN POWER ALLOWANCES						
AIRFLOW	MULTI-ZONE VAV SYSTEMS[1] ≤5,000 cfm	MULTI-ZONE VAV SYSTEMS[1] >5,000 and ≤10,000 cfm	MULTI-ZONE VAV SYSTEMS[1] >10,000 cfm	ALL OTHER FAN SYSTEMS ≤5,000 cfm	ALL OTHER FAN SYSTEMS >5,000 and ≤10,000 cfm	ALL OTHER FAN SYSTEMS >10,000 cfm
Supply Fan System Additional Allowance	0.135	0.114	0.105	0.139	0.12	0.107
Supply Fan System Additional Allowance in Unit with Adapter Curb	0.033	0.033	0.043	0.000	0.000	0.000
Exhaust/Relief/Return/Transfer Fan System Additional Allowance	0.07	0.061	0.054	0.07	0.062	0.055
Exhaust/Relief/Return/Transfer Fan System Additional Allowance in Unit with Adapter Curb	0.016	0.017	0.022	0.000	0.000	0.000

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) for the definition of a multi-zone VAV system.

ii. New or replacement single zone packaged rooftop systems with direct expansion cooling with rated cooling capacity less than 65,000 Btu/hr shall meet the applicable requirements specified in Table 141.0-E-1 or shall meet the performance compliance requirements of Section 141.0(b)3.

Table 141.0-E-1—NEW OR REPLACEMENT SINGLE ZONE AIR CONDITIONER OR HEAT PUMP REQUIREMENT																
BUILDING TYPE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Retail and grocery	NR	NR	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	NR	SZHP or SZAC1	NR
School	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	NR
Office, financial institution	NR	NR	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC2	SZHP or SZAC1	SZHP or SZAC1	NR	SZHP or SZAC1	NR
Library	SZHP or SZAC1	NR	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	SZHP or SZAC1	NR

SZHP = Single Zone Heat Pump + Economizer in accordance with Section 140.4(e).
SZAC1 = Single Zone Air Conditioner with furnace + Variable Speed Fan, + Economizer in accordance with Section 140.4(e), or Dual Fuel Heat Pump + Variable Speed Fan + Economizer in accordance with Section 140.4(e).
NR = No Requirement.

Air conditioners with furnaces or dual fuel heat pumps complying with Table 141.0-E-1 using variable speed fan and controls shall be designed to vary the indoor fan airflow rate as a function of the load and shall have a minimum of two stages of fan control. The minimum speed at stage 1 shall be set for ventilation only mode and shall be the greater of 50 percent or the minimum fan speed required to meet the minimum ventilation airflow rate. The indoor fan shall draw not more than 30 percent of the fan power at full fan speed when operating at 50 percent speed.

Exception to Section 141.0(b)2Cii: Section 141.0(b)2Cii is not applicable if the alteration exceeds the existing main service panel or service transformer capacity. An electrical load calculation shall be submitted by a registered professional engineer in accordance with Article 220 of the *California Electrical Code*.

Exception 1 to Section 141.0(b)2C: Section 140.4(a)2 shall not apply to new or replacement space conditioning systems or components. Section 140.4(a)3 shall not apply to new or replacement space conditioning systems or components.

Exception 2 to Section 141.0(b)2C: Subsection (b)2C does not apply to replacement of electric reheat of equivalent or lower capacity electric resistance space heaters, when natural gas is not available.

Exception 3 to Section 141.0(b)2C: Section 140.4(n) is not applicable to newly installed or replacement space conditioning systems with existing operable wall or roof openings without interlock controls.

Exception 4 to Section 141.0(b)2C: A new or replacement gas hot water boiler system with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h need not comply with the requirements of Section 140.4(k)8.

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Exception 5 to Section 141.0(b)2C: Requirements for the use of ASHRAE Guideline 36 in Sections 140.4(c)2Bii, 140.4(d)2Av, 140.4(e)2D, 140.4(f)3, and 140.4(r) shall not apply to new or replacement components unless the space-conditioning systems are also new or replacements.

Exception 6 to Section 141.0(b)2C: Section 140.4(e) is not applicable to systems that meet both of the following:

1. The system is not a single package air-cooled commercial unitary air conditioner or heat pump; and
2. The cooling capacity of the system is less than 54,000 Btu/h.

D. **Altered duct systems.** New or replacement space-conditioning system ducts installed to serve an existing building shall meet the requirements of Section 120.4 (a) through (f) and meet i, ii or iii below:

i. Entirely new or complete replacement duct systems installed as part of an alteration shall be leakage tested in accordance with Section 120.4(g). This applies to replacement duct systems installed as part of an alteration that are constructed of at least 75 percent new duct material. Up to 25 percent of that alteration may consist of reused parts from the building's existing duct system (including registers, grilles, boots, air handlers, coils, plenums and ducts) if the reused parts are accessible and can be sealed to prevent leakage.

ii. If the new ducts are an extension of an existing duct system and the combined new and existing duct system meets the criteria in Subsections 1, 2, 3 and 4 below, the duct system shall be sealed to a leakage rate not to exceed 15 percent of the nominal air handler airflow rate as confirmed through acceptance testing, in accordance with the applicable procedures in Reference Nonresidential Appendix NA7.5.3:

1. The duct system does not serve a healthcare facility;
2. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system;
3. The space-conditioning system serves less than 5,000 square feet of conditioned floor area; and
4. The combined surface area of the ducts located outdoors or in unconditioned space is more than 25 percent of the total surface area of the entire duct system.

Exception 1 to Section 141.0(b)2Dii: When it is not possible to achieve the duct leakage criteria in Section 141.0(b)2Dii, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified mechanical acceptance test technician utilizing the methods specified in Reference Nonresidential Appendix NA7.5.3.

Exception 2 to Section 141.0(b)2Dii: Duct sealing. Existing duct systems that are extended, which are constructed insulated or sealed with asbestos are not required to comply with Subsection 141.0(b)2Dii.

iii. If new ducts installed as part of an alteration are not required to comply with leakage testing specified by Section 141.0(b)2Di or 141.0(b)2Dii, then the new ducts shall meet the duct leakage testing requirements of CMC Section 603.9.2.

E. **Altered space-conditioning systems.** When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

i. For all altered units where the existing thermostat does not comply with the requirements for demand responsive controls specified in Section 110.12, the existing thermostat shall be replaced with a demand responsive thermostat that complies with Section 110.12. All newly installed space-conditioning systems requiring a thermostat shall be equipped with a demand responsive thermostat that complies with Section 110.12; and

ii. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed in accordance with Section 141.0(b)2Dii.

Exception 1 to Section 141.0(b)2Eii: Duct sealing. Buildings altered so that the duct system no longer meets the criteria of Section 141.0(b)2Dii.

Exception 2 to Section 141.0(b)2Eii: Duct sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in Reference Nonresidential Appendix NA2.

Exception 3 to Section 141.0(b)2Eii: Duct sealing. Existing duct systems constructed, insulated or sealed with asbestos are not required to comply with Subsection 141.0(b)2Eii.

F. Spaces with lighting systems installed for the first time shall meet the requirements of Sections 110.9, 130.0, 130.1, 130.2, 130.4, 140.3(c), 140.6 and 140.7.

G. When the requirements of Section 130.1(d) are triggered by the addition of skylights to an existing building and the lighting system is not recircuited, the daylighting control need not meet the multilevel requirements in Section 130.1(d).

H. New internally and externally illuminated signs shall meet the requirements of Sections 110.9, 130.3 and 140.8.

I. **Altered indoor lighting systems.** Alterations to indoor lighting systems that include 10% or more of the luminaires serving an enclosed space shall meet the requirements of i, ii, or iii below:

i. The alteration shall comply with the indoor lighting power requirements specified in Section 140.6 and the lighting control requirements specified in Table 141.0-F;

ii. The alteration shall not exceed 80% of the indoor lighting power requirements specified in Section 140.6, and shall comply with the lighting control requirements specified in Table 141.0-F; or

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iii. The alteration shall be a one-for-one luminaire alteration within a building or tenant space of 5,000 square feet or less, the total wattage of the altered luminaires shall be at least 40% lower compared to their total pre-alteration wattage, and the alteration shall comply with the lighting control requirements specified in Table 141.0-F.

Alterations to indoor lighting systems shall not prevent the operation of existing, unaltered controls, and shall not alter controls to remove functions specified in Section 130.1.

Alterations to lighting wiring are considered alterations to the lighting system. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display, or decorative lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Section 130.1(a)3.

Exception 1 to Section 141.0(b)2I: Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded as specified in Section 140.6(a)3.

Exception 2 to Section 141.0(b)2I: Any enclosed space with only one luminaire.

Exception 3 to Section 141.0(b)2I: Any alteration that would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

Exception 4 to Section 141.0(b)2I: Acceptance testing requirements of Section 130.4 are not required for alterations where lighting controls are added to control 20 or fewer luminaires.

Exception 5 to Section 141.0(b)2I: Any alteration limited to adding lighting controls or replacing lamps, ballasts, or drivers.

Exception 6 to Section 141.0(b)2I: One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.

J. **Reserved.**

K. **Reserved.**

L. Alterations to existing outdoor lighting systems in a lighting application listed in Table 140.7-A or 140.7-B shall meet the applicable requirements of Sections 130.0, 130.2(b) and 130.4, and:

i. In alterations that increase the connected lighting load, the added or altered luminaires shall meet the applicable requirements of Section 130.2(c) and the requirements of Section 140.7 for general hardscape lighting or for the specific lighting applications containing the alterations; and

ii. In alterations that do not increase the connected lighting load, where 10 percent or more of the existing luminaires are replaced in a general hardscape or a specific lighting application, the alterations shall meet the following requirements:

a. In parking lots and outdoor sales lots where the bottom of the luminaire is mounted 24 feet or less above the ground, the replacement luminaires shall comply with Section 130.2(c)1 AND Section 130.2(c)3; and

b. For parking lots and outdoor sales lots where the bottom of the luminaire is mounted greater than 24 feet above the ground and for all other lighting applications, the replacement luminaires shall comply with Section 130.2(c)1 and either comply with Section 130.2(c)2 or be controlled by lighting control systems, including motion sensors, that automatically reduce lighting power by at least 40 percent in response to the area being vacated of occupants.

Exception to Section 141.0(b)2Lii: Alterations where fewer than five existing luminaires are replaced.

iii. In alterations that do not increase the connected lighting load, where 50 percent or more of the existing luminaires are replaced in general hardscape or a specific application, the replacement luminaires shall meet the requirements of Subsection ii above and the requirements of Section 140.7 for general hardscape lighting or specific lighting applications containing the alterations.

Exception 1 to Section 141.0(b)2Liii: Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires are not required to comply with the lighting power allowances of Section 140.7.

Exception 2 to Section 141.0(b)2Liii: Alterations where fewer than five existing luminaires are replaced.

Exception to Section 141.0(b)2L: Acceptance testing requirements of Section 130.4 are not required for alterations where controls are added to 20 or fewer luminaires.

M. Alterations to existing internally and externally illuminated signs that increase the connected lighting load, replace and rewire more than 50 percent of the ballasts, or relocate the sign to a different location on the same site or on a different site shall meet the requirements of Section 140.8.

Exception to Section 141.0(b)2M: Replacement of parts of an existing sign, including replacing lamps, the sign face or ballasts, that do not require rewiring or that are done at a time other than when the sign is relocated, is not an alteration subject to the requirements of Section 141.0(b)2M.

N. Service water-heating systems shall meet the requirements of Sections 140.5(a)2 and b, except for the solar water heating requirements.

O. A building shell for which interior walls or ceilings are installed for the first time shall meet the requirements of Section 140.3(c).

P. **Electrical power distribution systems.** Alterations to electrical power distribution systems shall meet the applicable requirements of Section 130.5 as follows:

i. Service electrical metering. New or replacement electrical service equipment shall meet the requirements of Section 130.5(a) applicable to the electrical power distribution system altered.

ii. Separation of electrical circuits for electrical energy monitoring. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 130.5(b).

iii. Voltage drop. Alterations of feeders and branch circuits where the alteration includes addition, modification, or replacement of both feeders and branch circuits, the altered circuits shall meet the requirements of Section 130.5(c).

Exception to Section 141.0(b)2Piii: Voltage drop permitted by *California Electrical Code* Sections 647.4, 695.6 and 695.7.

iv. Circuit controls for 120-volt receptacles and controlled receptacles. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Sections 130.5(d) and 130.5(e).

Q. Existing building envelope wall where 25 percent or more of the wall area is being altered must comply with Section 140.3(a)9. Where the building is tested in accordance with the procedures for whole building air leakage in NA5.1 and the tested leakage rate exceeds 0.4 cfm/ft^2 of building shell at 75 pascals, a visual inspection and diagnostic evaluation shall be done in accordance with NA5.7 and all observed leaks shall be sealed where such sealing can be made without destruction of existing building components.

Exception to Section 141.0(b)2Q: Healthcare facilities.

R. **Exterior doors.** Alterations that add exterior door area shall meet the *U*-factor requirements of Section 140.3(a)7.

3. **Performance approach.**

A. The altered envelope, space-conditioning system, lighting and water heating components, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5.

Exception 1 to Section 141.0(b)3A: Window films. Applied window films installed as part of an alteration complies with the *U*-factor, RSHGC and VT requirements of Table 141.0-E-2.

Exception 2 to Section 141.0(b)3A: The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

TABLE 141.0-E-2—THE STANDARD DESIGN FOR AN ALTERED COMPONENT

ALTERED COMPONENT	STANDARD DESIGN WITHOUT THIRD-PARTY VERIFICATION OF EXISTING CONDITIONS SHALL BE BASED ON	STANDARD DESIGN WITH THIRD-PARTY VERIFICATION OF EXISTING CONDITIONS SHALL BE BASED ON
Roof/ceiling insulation, wall insulation, and floor/soffit insulation	The requirements of Section 141.0(b)1 and 141.0(b)2Bii.	
Fenestration The allowed glass area shall be the smaller of a. or b. below: a. The proposed glass area: or b. The larger of: 1. The existing glass area that remains; or 2. The area allowed in Section 140.3(a)5A.	The *U*-factor and RSHGC requirements of Table 141.0-A.	The existing *U*-factor and RSHGC levels.
Space-conditioning system equipment and ducts	The requirements of Section 141.0(b)2C, 141.0(b)2Di or 141.0(b)2Dii, and Section 141.0(b)2E.	
Window film	The *U*-factor of 0.40 and SHGC value of 0.35.	The existing fenestration in the alteration shall be based on Tables 110.6-A and 110.6-B.
Service water heating systems	The requirements of Section 140.5 without solar water heating requirements.	
Roofing products	The requirements of Section 141.0(b)2B.	
Lighting system	The requirements of Sections 141.0(b)2F through 141.0(b)2K.	
All other measures	The proposed efficiency levels.	

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TABLE 141.0-F—CONTROL REQUIREMENTS FOR INDOOR LIGHTING SYSTEM ALTERATIONS			
CONTROL SPECIFICATIONS		**PROJECTS COMPLYING WITH SECTION 141.0(B)2Ii**	**PROJECTS COMPLYING WITH SECTION 141.0(B)2Iii OR 141.0(B)2Iiii**
Manual Area Controls	130.1(a)1	Required	Required
	130.1(a)2	Required	Required
	130.1(a)3	Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multi-Level Controls	130.1(b)	Required	Not Required
Automatic Shut-off Controls	130.1(c)1	Required	Required
	130.1(c)2	Required	Required
	130.1(c)3	Required	Required
	130.1(c)4	Required	Required
	130.1(c)5	Required	Required
	130.1(c)6	Required	Required; except for 130.1(c)6D
	130.1(c)8	Required	Required
Daylight Responsive Controls	130.1(d)	Required	Not Required
Demand Responsive Controls	110.12(a) and 110.12(c)	Required	Not Required

B. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements of Section 141.0(b)2. For components not being altered, the standard design shall be based on the unaltered existing conditions such that the standard and proposed designs for these components are identical.

C. When the third party verification option is specified, all components proposed for alteration, for which the additional credit is taken, must be verified. The Executive Director shall determine the qualifications required by the third party inspector.

D. The proposed design shall be based on the actual values of the altered components.

Notes to Section 141.0(b)3:

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and must therefore meet the requirements of Section 141.0(b)3.
2. The standard design assumes the same geometry and orientation as the proposed design.
3. The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in the *Nonresidential ACM Reference Manual.*

Exception 1 to Section 141.0(b): When heating, cooling or service water heating for an alteration are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.

Exception 2 to Section 141.0(b): When existing heating, cooling or service water heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.

Exception 3 to Section 141.0(b): Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of Section 140.4(g).

Exception 4 to Section 141.0(b): The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

(c) **Repairs.** Repairs shall not increase the preexisting energy consumption of the repaired component, system or equipment.

(d) **Alternate method of compliance.** Any addition, alteration or repair may comply with the requirements of Title 24, Part 6 by meeting the applicable requirements for the entire building.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25910, and 25943, *Public Resources Code*.

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SECTION 141.1—REQUIREMENTS FOR COVERED PROCESSES IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL AND HOTEL/MOTEL BUILDINGS

Covered processes in additions or alterations to existing buildings that will be nonresidential and hotel/motel occupancies shall comply with the applicable Subsections of Section 120.6 and 140.9.

(a) **Lab and Process Facility Exhaust Systems.** Additions and alterations to existing laboratories and factories shall meet the requirements of Section 140.9(c).

(b) **Computer Rooms.** All newly installed computer room cooling systems and uninterruptible power supply systems in additions/alterations shall meet the requirements of Sections 120.6(j), 140.9(a)2 and 140.9(a)4 and comply with Item 1 below.

1. **Economizers.** Each individual cooling system primarily serving computer rooms in an existing building shall include either:
   A. An integrated air economizer capable of partial cooling when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i); or
   B. An integrated water economizer capable of partial cooling when additional mechanical cooling is required and capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below.

   Exception 1 to Section 141.1(b)1: Individual computer rooms with an ITE design load under 5 tons (18 kW) in a building that does not have any economizers.

   Exception 2 to Section 141.1(b)1: New cooling systems serving an existing computer room in an existing building with an ITE design load up to a total of 50 tons (176 kW).

   Exception 3 to Section 141.1(b)1: New cooling systems serving a new computer room in an existing building with an ITE design load up to a total of 20 tons (70 kW).

(c) **Controlled Environment Horticulture Spaces.**

1. Indoor growing, space-conditioning systems and dehumidification. All newly installed heating, ventilation, air conditioning systems or dehumidification systems in buildings with indoor growing shall meet the applicable requirements of Sections 120.6(h)1 and 120.6(h)2.
2. Greenhouses, building envelope and space-conditioning systems. A greenhouse being converted to a conditioned greenhouse or additions to a conditioned greenhouse shall meet the requirements of Sections 120.6(h)3 and 120.6(h)4.
3. Indoor growing and greenhouses, horticultural lighting. When alterations to horticultural lighting systems increase lighting wattage or include adding, replacing or altering 10 percent or more of the horticultural luminaires serving an enclosed space, the newly installed, replaced or altered lighting shall meet the requirements of Section 120.6(h)5.

   Exception to Section 141.1(c)3: Any alteration limited to adding lighting controls or replacing lamps, ballasts or drivers.

(d) **Process piping.** Newly installed process heating and process cooling system piping and pipes relocated as part of an alteration shall meet the requirements of Section 120.3.

NOTE: For alterations that change the occupancy classification of the building, the requirements of Section 141.1 apply to the occupancy that will exist after the alterations.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, *Public Resources Code.*

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SUBCHAPTER

7

SINGLE-FAMILY RESIDENTIAL BUILDINGS—MANDATORY FEATURES AND DEVICES

SECTION 150.0—MANDATORY FEATURES AND DEVICES

Single-family residential buildings shall comply with the applicable requirements of Sections 150(a) through 150.0(v).

NOTE: The requirements of Sections 150.0(a) through 150.0(v) apply to newly constructed buildings. Sections 150.2(a) and 150.2(b) specify which requirements of Sections 150.0(a) through 150.0(v) also apply to additions or alterations.

(a) **Roof deck, ceiling and rafter roof insulation.** The opaque portions of roof decks separating attic spaces from ambient air, and ceilings or rafter roofs separating conditioned spaces from unconditioned spaces or ambient air, shall meet the requirements of Items 1 through 4 below:

1. In Climate Zones 4 and 8 through 16, roof decks in newly constructed attics that are above conditioned space shall be insulated to achieve an area-weighted average *U*-factor not exceeding U-0.184.

   Exception 1 to Section 150.0(a)1:

   i. The space-conditioning system air handler and ducts are located entirely in conditioned space below the ceiling separating the occupiable space from the attic; or

   ii. The space-conditioning system air handler is located in unconditioned space and has 12 linear feet or less of supply duct, including the length of the air handler and the plenum, located in unconditioned space, with all other portions of the supply ducts located in conditioned space below the ceiling separating the occupiable space from the attic; or

   iii. The space-conditioning system is a ductless system.

   Exception 2 to Section 150.0(a)1: Space-conditioning duct systems buried within insulation in an attic that complies using Section 150.1(b) and is verified according to RA 3.1.4.1.

2. Ceilings and rafter roofs shall be insulated to achieve an area-weighted average *U*-factor not exceeding U-0.043 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-22 or greater for the insulation alone. For vented attics, the mandatory insulation shall be installed at the ceiling level; for unvented attics, the mandatory insulation shall be placed at either ceiling or roof level; and

   Exception to Section 150.0(a)2: Ceilings and rafter roofs in an alteration shall be insulated to achieve an area-weighted average U-factor not exceeding 0.054 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater.

3. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage; and

4. Insulation shall be installed in direct contact with a roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.

(b) **Loose-fill insulation.** When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled *R*-value.

(c) **Wall insulation.** Opaque portions of above grade walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the following requirements:

1. 2 × 4 inch framing shall have an overall assembly *U*-factor not exceeding U-0.095

   Exception to Section 150.0(c)1: Existing walls already insulated to a *U*-factor not exceeding U-0.110 or already insulated between framing members with insulation having an installed thermal resistance of R-11 or greater.

2. 2 × 6 inch or greater framing shall have an overall assembly *U*-factor not exceeding U-0.069.

3. Opaque nonframed assemblies shall have an overall assembly *U*-factor not exceeding U-0.102.

4. Bay or bow window roofs and floors shall be insulated to meet the wall insulation requirements of Table 150.1-A.

5. Masonry/mass walls shall be insulated to meet the wall insulation requirements of Table 150.1-A.

6. In wood framed assemblies, compliance with *U*-factors may be demonstrated by installing wall insulation with an *R*-value of R-15 in 2x4 assemblies, and R-21 in 2x6 assemblies with 16 inches on center spacing.

(d) **Raised-floor insulation.** Raised floors separating conditioned space from unconditioned space or ambient air shall have an overall assembly *U*-factor not exceeding U-0.037. In a wood framed assembly, compliance with the *U*-factor may be demonstrated by installing insulation with an *R*-value of 19 or greater.

Exception to Section 150.0(d): A building with a controlled ventilation or unvented crawlspace may omit raised floor insulation if all of the following are met:

i. The foundation walls are insulated to meet the wall insulation minimums as shown in Table 150.1-A; and

ii. A Class I or Class II vapor retarder is placed over the entire floor of the crawl space; and

iii. Vents between the crawlspace and outside air are fitted with automatically operated louvers that are temperature actuated; and

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iv. The requirements in Reference Residential Appendix RA4.5.1.

(e) **Installation of fireplaces, decorative gas appliances and gas logs.** If a masonry or factory-built fireplace is installed, it shall comply with Section 110.5, Section 4.503 of Part 11, and shall have the following:

1. Closable metal or glass doors covering the entire opening of the firebox; and
2. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable and tight-fitting damper or combustion-air control device; and

   Exception to Section 150.0(e)2: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.
3. A flue damper with a readily accessible control.

   Exception to Section 150.0(e)3: When a gas log, log lighter or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.

(f) **Slab edge insulation.** Material used for slab edge insulation shall meet the following minimum specifications:

1. Water absorption rate for the insulation material alone without facings no greater than 0.3 percent when tested in accordance with Test Method A – 24-Hour-Immersion of ASTM C272.
2. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E96.
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration.
4. Insulation for a heated slab floor shall meet the requirements of Section 110.8(g).

(g) **Vapor retarder.**

1. In Climate Zones 1–16, the earth floor of unvented crawl space shall be covered with a Class I or Class II vapor retarder. This requirement shall also apply to controlled ventilation crawl space for buildings complying with the Exception to Section 150.0(d).
2. In Climate Zones 14 and 16, a Class I or Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.

(h) **Space-conditioning equipment.**

1. Building cooling and heating loads. Building heating and cooling loads shall be determined using a method based on any one of the following:
   A. The ASHRAE Handbook, Equipment Volume, Applications Volume and Fundamentals Volume; or
   B. The SMACNA Residential Comfort System Installation Standards Manual; or
   C. The ACCA Manual J.

   Exception 1 to Section 150.0(h)1: Block loads, the total load for all rooms combined that are served by the central equipment, may be used for the purpose of system sizing for additions.
2. **Design conditions.** Design conditions shall be determined in accordance with the following:
   A. For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling.
   B. Outdoor design conditions shall be selected from one of the following:
      i. Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X; or
      ii. The ASHRAE Handbook, Fundamentals Volume; or
      iii. The ACCA Manual J.
   C. The outdoor design temperatures for heating shall be no lower than the 99.0 percent Heating Dry Bulb or the Heating Winter Median of Extremes values.
   D. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.
3. **Outdoor condensing units.**
   A. **Clearances.** Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least five (5) feet (1.5 meters) from the outlet of any dryer vent.
   B. **Liquid line drier.** Installed air conditioner and heat pump systems shall be equipped with liquid line filter driers if required, as specified by manufacturer's instructions.
4. **Central forced-air heating furnaces.**
   A. **Temperature rise.** Central forced-air heating furnace installations shall be configured to operate in conformance with the furnace manufacturer's maximum inlet-to-outlet temperature rise specifications.
5. **System selection.**
   A. Equipment sizing and selection shall meet the cooling and heating loads of Sections 150.0(h)1 and 2.
   B. Systems shall be sized based on ACCA Manual S-2023 in accordance with these requirements:
      i. **Cooling capacity:** There is no limit on the minimum capacity.
      ii. **Furnaces:** Heating capacity shall be sized based on ACCA Manual S-2023, Table N2.5.

iii. **Heat pump heating capacity:**

a. **Minimum:** Heating systems are required to have a heating capacity meeting the minimum requirements of the CBC, not including any supplementary heating.

b. **Maximum:** There is no limit on the maximum heating capacity.

6. **Defrost.**

A. If a heat pump is equipped with an installer adjustable defrost delay timer, the delay timer shall be set to greater than or equal to 90 minutes.

B. The installer shall certify on the Certificate of Installation (CF2R) that the control configuration has been tested in accordance with the testing procedure in the CF2R.

Exception 1 to Section 150.0(h)6. Dwelling units in Climate Zones 6 and 7.

Exception 2 to Section 150.0(h)6. Dwelling units with a conditioned floor area of 500 square feet or less in Climate Zones 3, 5 through 10, and 15.

7. **Supplementary heating control configuration.** Heat pumps with supplementary heat, including, but not limited to, electric resistance heaters or gas furnace supplementary heating, shall comply with the following requirements:

A. Lock out supplementary heating above an outdoor air temperature of not greater than 35°F. There are additional thermostat requirements in section 150.0(i)2.

B. The installer shall certify on the Certificate of Installation that the control configuration has been tested in accordance with the testing procedure found in the CF2R.

C. The controls may allow supplementary heater operation above 35°F only during defrost or when the user selects emergency operation.

Exception 1 to Section 150.0(h)7: For buildings with a conditioned floor area less than 500 square feet, and for buildings of any size in Climate Zones 7 and 15, heat pumps with supplementary heaters shall have controls that meet Item i or ii:

i. Option A:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and

2. In which the cut-on temperature for heat pump heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for heat pump heating is higher than the cut-off temperature for supplementary heating.

ii. Option B: The controls may allow supplementary heater operation during defrost mode and transient periods, such as start-ups and following a room thermostat setpoint advance, if the controls prevent the unnecessary operation of supplementary heating.

Exception 2 to Section 150.0(h)7: Room air-conditioner heat pumps.

8. **Sizing of electric resistance supplementary heat.** Where heat pumps have electric resistance heat, the capacity of electric resistance heat shall not exceed the heat pump nominal cooling capacity (at 95°F ambient conditions) multiplied by 2.7 kW per ton, rounded up to the closest kW.

9. **Capacity variation with third-party thermostats.** Variable or multi-speed systems shall comply with the following requirements:

A. The space conditioning system and thermostat together shall be capable of responding to heating and cooling loads by modulating system compressor speed, and meet thermostat requirements in Section 150.0(i)2.

B. The installer shall certify on the Certificate of Installation that the control configuration has been tested in accordance with the testing procedure found in the CF2R.

(i) **Thermostats.**

1. **Setback thermostats.** All heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat, as specified in Section 110.2(c).

2. **Thermostats that are applied to heat pumps with supplemental heating.** In addition to the requirements in Section 150.0(i)1, thermostats controlling heat pumps with electric resistance supplementary heat or gas furnace supplementary heat shall comply with the following requirements:

A. The thermostat shall receive outdoor air temperature from an outdoor air temperature sensor or from an internet weather service.

B. The thermostat shall display the outdoor air temperature.

C. As described in Section 150.0(h)7, the thermostat and heat pump shall lock out supplementary heat when the outdoor air temperature is above 35°F.

D. The thermostat shall have an indicator to notify when supplementary heat or emergency heat is in use.

E. During defrost or when the user selects emergency heating, supplementary heat operation is permitted above 35°F.

F. The installer shall certify on the Certificate of Installation that the system has been tested in accordance with the testing procedure found in the CF2R.

Exception to Section 150.0(i)2A, B, and C: Where supplementary heat is locked out above 35°F by another control device in accordance with Section 150.0(h)7.

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Exception 1 to Section 150.0(i)2: Systems compliant with Exception 1 to Section 150.0(h)7.

Exception 2 to Section 150.0(i)2: Room air-conditioner heat pumps.

(j) **Insulation for piping and tanks.**

1. **Water piping, solar water-heating system piping, and space-conditioning system line insulation thickness and conductivity.** Piping shall be insulated as follows:
   A. All domestic hot water piping shall be insulated as specified in Section 609.12 of the *California Plumbing Code*.
   B. Piping for space-conditioning systems, solar water-heating system collector loop, and distribution piping for steam and hydronic heating system shall meet the requirements of Section 120.3(a).

      Exception 1 to Section 150.0(j)1: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

      Exception 2 to Section 150.0(j)1: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing. Insulation shall butt securely against all framing members.

      Exception 3 to Section 150.0(j)1: Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with quality insulation installation (QII) as specified in the Reference Residential Appendix RA3.5.

      Exception 4 to Section 150.0(j)1: Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawlspace insulation, or 4 inches of attic insulation shall not be required to have pipe insulation.
2. **Insulation protection.** Pipe insulation shall meet the insulation protection requirements of Section 120.3(b).

(k) **Residential lighting.**

1. **Luminaire requirements.**
   A. **Luminaire efficacy.** All installed luminaires and light sources shall comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.

      Exception 1 to Section 150.0(k)1A: Integrated device lighting. Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, garage door openers, and ceiling fan kits that are subject to DOE's Appliance and Equipment Standards Program.

      Exception 2 to Section 150.0(k)1A: Navigation lighting rated less than 5 watts, such as night lights, step lights, and path lights.

      Exception 3 to Section 150.0(k)1A: Lighting with an efficacy of 45 lumens per watt or greater and located internal to drawers, cabinetry, or linen closets.

      Exception 4 to Section 150.0(k)1A: Light sources as follows:
      i. LED light sources installed outdoors;
      ii. Inseparable solid state lighting (SSL) luminaires containing colored light sources that are installed to provide decorative lighting;
      iii. High-intensity discharge (HID) light sources, including pulse start metal halide and high-pressure sodium light sources; and
      iv. Luminaires with hardwired high-frequency generator and induction lamp.
   B. Reserved.
   C. **Recessed downlight luminaires in ceilings.** Luminaires recessed into ceilings shall meet all of the following requirements:
      i. Shall not contain screw base lamp sockets; and
      ii. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 cfm at 75 Pascals when tested in accordance with ASTM E283. An exhaust fan housing with integral light shall not be required to be certified airtight; and
      iii. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk, or be installed per manufacturer's instructions to maintain airtightness between the luminaire housing and ceiling; and
      iv. Meet the clearance and installation requirements of *California Electrical Code* Article 410.116 for recessed luminaires.

         Exception to Sections 150.0(k)1Cii and iii: Recessed luminaires marked for use in fire-rated installations extruded into ceiling space and recessed luminaires installed in noninsulated ceilings.
   D. **Light sources in enclosed or recessed luminaires.** Lamps and other separable light sources in enclosed or recessed luminaires shall be in compliance with the JA8 elevated temperature requirements, including marking requirements.
   E. **Blank electrical boxes.** The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes shall be served by a dimmer, vacancy sensor control, low voltage wiring or fan speed control.

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2. **Indoor lighting controls.**
   A. Lighting shall have readily accessible wall-mounted controls that allow the lighting to be manually turned ON and OFF.

      Exception to Section 150.0(k)2A: Ceiling fans may provide control of integrated lighting via a remote control.
   B. Reserved.
   C. **All lighting controls.** Lighting controls shall comply with the applicable requirements of Section 110.9.
   D. **Controls permitted.** An energy management control system (EMCS) or a multiscene programmable control may be used to comply with dimming, occupancy and lighting control requirements in Section 150.0(k)2 if it provides the functionality of the specified controls in accordance with Section 110.9, and the physical controls specified in Section 150.0(k)2A. No controls shall bypass control functions of a dimmer, occupant sensor, or vacancy sensor where the dimmer or sensor has been installed to comply with Section 150.0(k)2.
   E. **Automatic-off controls.**
      i. In bathrooms, garages, laundry rooms, utility rooms and walk-in closets, at least one installed luminaire shall be controlled by an occupancy or vacancy sensor providing automatic-off functionality.
      ii. For lighting internal to drawers and cabinetry with opaque fronts or doors, controls that turn the light off when the drawer or door is closed shall be provided.
   F. **Dimming controls.** Lighting in habitable spaces, including living rooms, dining rooms, kitchens, and bedrooms, shall have readily accessible wall-mounted dimming controls that allow the lighting to be manually adjusted up and down. Forward phase cut dimmers controlling LED light sources in these spaces shall comply with NEMA SSL 7A.

      Exception 1 to Section 150.0(k)2F: Ceiling fans may provide control of integrated lighting via a remote control. Lighting integral to kitchen range hoods and bathroom exhaust fans.

      Exception 2 to Section 150.0(k)2F: Luminaires connected to a circuit with controlled lighting power less than 20 watts or controlled by an occupancy or vacancy sensor providing automatic-off functionality.

      Exception 3 to Section 150.0(k)2F: Navigation lighting rated less than 5 watts, such as night lights, step lights, and path lights. Lighting controlled by automatic-off controls and located internal to drawers, cabinetry with opaque fronts, or cabinetry with doors.
   G. **Independent controls.** Lighting integrated with the exhaust fans shall be controlled independently from the fans. The following shall be controlled separately from ceiling-installed lighting such that one can be turned on without turning on the other:
      i. Undercabinet lighting.
      ii. Undershelf lighting.
      iii. Interior lighting of display cabinets.
      iv. Switched outlets.
3. **Residential outdoor lighting.** In addition to meeting the requirements of Section 150.0(k)1A, luminaires providing residential outdoor lighting shall meet the following requirements, as applicable:
   A. Outdoor lighting permanently mounted to a residential building or to other buildings on the same lot shall meet the following requirements:
      i. Controlled by a manual ON and OFF control switch that permits the automatic actions of Item ii below; and
      ii. Controlled by one of the following controls:
         a. A photocell and a motion sensor; or
         b. A photocell and an automatic time switch control; or
         c. Controlled by an astronomical time clock control.
   B. Controls that override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within 6 hours.
   C. An energy management control system (EMCS) or other controls that provides the specified lighting control functionality and complies with all requirements applicable to the specified controls may be used to meet these requirements.
4. **Internally illuminated address signs.** Internally illuminated address signs shall either:
   A. Comply with Section 140.8; or
   B. Consume no more than 5 watts of power.
5. **Residential garages for eight or more vehicles.** Lighting for residential parking garages for eight or more vehicles shall comply with the applicable requirements for nonresidential garages in Sections 110.9, 130.0, 130.1, 130.4, 140.6 and 141.0.

(l) **Reserved.**

(m) **Air-distribution and ventilation system ducts, plenums and fans.**

1. **CMC compliance.**
   A. All air-distribution system ducts and plenums, including but not limited to, mechanical closets and air-handler boxes, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, incorporated herein by reference.

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B. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall be insulated in accordance with either Subsection i or ii below:

i. Ducts shall have a minimum installed level of R-6.0, or

Exception 1 to Section 150.0(m)1Bi: Portions of the duct system located in conditioned space below the ceiling separating the occupiable space from the attic are not required to be insulated if all of the following conditions are met:

a. The noninsulated portion of the duct system is located entirely inside the building's thermal envelope as confirmed by visual inspection.

b. At all locations where noninsulated portions of the duct system penetrate into unconditioned space, the penetration shall be draft stopped compliant with CFC Sections 703.1 and 704.1 and air-sealed to the construction materials that are penetrated, using materials compliant with CMC Section E502.4.2 to prevent air infiltration into the cavity. All connections in unconditioned space are insulated to a minimum of R-6.0 as confirmed by visual inspection.

Exception 2 to Section 150.0(m)1Bi: Ducts located in an unvented attic shall have a minimum insulation value of R-4.2, verified by visual inspection where:

a. The attic has at least R-30 insulation between the roof rafters in contact with the roof deck.

b. The gable ends meet the wall insulation requirements of Section 150.1(c)1B.

c. The dwelling unit achieves a whole building leakage rate of 3.0 ACH50 or less, as confirmed by field verification and diagnostic testing in accordance with Reference Residential Appendix RA3.8.

ii. Ducts do not require insulation when the duct system is located entirely within conditioned space, as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8. For dwelling units with attics, the duct system shall be located below the ceiling separating the occupiable space from the attic.

C. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened.

D. Openings shall be sealed with mastic, tape or other duct-closure system that meets the applicable requirements of UL 181, UL181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.

E. Building cavities, support platforms for air handlers and plenums designed or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

Exception to Section 150.0(m)1: Ducts and fans integral to a wood heater or fireplace.

2. **Factory-fabricated duct systems.**

A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

B. All pressure-sensitive tapes, heat-activated tapes and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

3. **Field-fabricated duct systems.**

A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.

B. Mastic sealants and mesh.

i. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 18IB, and be nontoxic and water resistant.

ii. Sealants for interior applications shall be tested in accordance with ASTM C731 and D2202 incorporated herein by reference.

iii. Sealants for exterior applications shall be tested in accordance with ASTM C731, C732 and D2202, incorporated herein by reference.

iv. Sealants and meshes shall be rated for exterior use.

C. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

E. Drawbands used with flexible duct.
   i. Drawbands shall be either stainless-steel worm- drive hose clamps or UV-resistant nylon duct ties.
   ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
   iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

F. Aerosol-sealant closures.
   i. Aerosol sealants shall meet the requirements of UL 723, and be applied according to manufacturer specifications.
   ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

4. **Duct insulation *R*-value ratings.** All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor retarder or other duct components) and tested *C*-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.
5. **Duct insulation thickness.** The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:
   A. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
   B. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
   C. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.
6. **Duct labeling.** Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor retarders or other duct components), based on the tests in Section 150.0(m)4 and the installed thickness determined by Section 150.0(m)5C.
7. **Backdraft dampers.** All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.
8. **Gravity ventilation dampers.** All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.
9. **Protection of insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.
10. **Porous inner core flex duct.** Flexible ducts having porous inner cores shall have a non-porous layer or air barrier between the inner core and the outer vapor barrier.
11. **Duct system sealing and leakage testing.** When space-conditioning systems utilize forced air duct systems to supply conditioned air to an occupiable space, the ducts shall be sealed as confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1, and conforming to one of the following Subsections A, B or C as applicable. Air handler airflow for calculation of duct leakage rate compliance targets shall be determined according to methods specified in Reference Residential Appendix RA3.1.4.2.
    A. For single-family dwellings and townhouses with the air-handling unit installed and the ducts connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.
    B. For single-family dwellings and townhouses at the rough-in stage of construction prior to installation of the dwelling's interior finishing:
       i. **Air-handling unit installed.** If the air-handling unit is installed and the ducts are connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.1 and RA3.1.4.3.3.
       ii. **Air-handling unit not yet installed.** If the air-handling unit is not yet installed, the total leakage of the duct system shall not exceed 4 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.2 and RA3.1.4.3.3.
12. **Air filtration.**
    A. System types specified in Subsections i, ii, and iii shall be provided with air filters in accordance with Sections 150.0(m)12B, 150.0(m)12C, and 150.0(m)12D. System types specified in Subsection i shall also comply with Section 150.0(m)12E.
       i. Mechanical space-conditioning systems that supply air to an occupiable space through ductwork exceeding 10 feet (3 m) in length.
       ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems, and energy recovery ventilation systems that provide outside air to an occupiable space.

Exception 1 to Section 150.0(m)12A: Evaporative coolers are not required to comply with the air filtration requirements in Section 150.0(m)12.

B. **System design and installation.**

i. The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through any system's thermal conditioning components.

Exception 1 to Section 150.0(m)12Bi: For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 150.0(m)12 may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

ii. All systems shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter(s). The design airflow rate and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter shall be determined and reported on labels according to Subsection iv below.

Systems specified in Section 150.0(m)12Ai shall be equipped with air filters that meet either Subsection a or b below.

a. Nominal two-inch minimum depth filter(s) shall be sized by the system designer, or

b. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 150.0-A, based on a maximum face velocity of 150 ft per minute, and according to the maximum allowable clean-filter pressure drop specified in Section 150.0(m)12Dii.

(Equation 150.0-A) $A_{face} = Q_{filter}/V_{face}$

where

A_{face} = air filter face area, the product of air filter nominal length x nominal width, ft^2.

Q_{filter} = design airflow rate for the air filter, ft^3/min.

V_{face} = air filter face velocity ≤ 150, ft/min.

iii. All system air filters shall be located and installed in such a manner as to be accessible for regular service by the system owner.

iv. All system air filter installation locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop. The labels shall be permanently affixed to the air filter installation location, readily legible, and visible to a person replacing the air filter.

v. Filter racks or grilles shall use gaskets, sealing or other means to close gaps around inserted filters to and prevent air from bypassing the filter.

C. **Air filter efficiency.** The system shall be provided with air filter(s) having a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30–1.0 µm range, and equal to or greater than 85 percent in the 1.0–3.0 µm range when tested in accordance with AHRI Standard 680.

D. **Air filter pressure drop.** All system shall be provided with air-filter(s) that conforms to the applicable maximum allowable clean-filter pressure drop specified in Subsections i, ii, iii, or iv below, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rate(s) for the system air filter(s).

i. The maximum allowable clean-filter pressure drop shall be determined by the system design for the nominal two-inch minimum depth air filter required by Section 150.0(m)12Biia, or

ii. A maximum of 25 PA (0.1 inches water) clean-filter pressure drop shall be allowed for a nominal one-inch depth air filter sized according to Section 150.0(m)12Biib, or

iii. For systems specified in 150.0(m)12Aii, and 150.0(m)12Aiii, the maximum allowable clean filter pressure drop shall be determined by the system design.

iv. If Exception 1 to Section 150.0(m)13B or D is utilized for compliance with cooling system airflow rate and fan efficacy requirements, the clean-filter pressure drop for the system air filter shall conform to the requirements given in Table 150.0-B or 150.0-C.

E. **Air filter product labeling.** Systems described in 150.0(m)12)Ai shall be equipped with air filters that have been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 150.0(m)12C and 150.0(m)12D.

13. **Space conditioning system** air**flow rate and fan efficacy.** Space conditioning systems that utilize forced air ducts to supply cooling to an occupiable space shall:

A. **Static pressure probe.** Have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location, and labeling of the HSPP or PSPP shall conform to the requirements specified in Reference Residential Appendix RA3.3.1.1 as confirmed by field verification and diagnostic testing; and

Exception to 150.0(m)13A: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.3-1 shall not be required to provide holes as described in Figure RA3.3-1.

B. **Single zone central forced air systems.** Demonstrate, in every control mode, airflow greater than or equal to 350 CFM per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to the maximum W/CFM specified in Subsections i or ii below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

i. 0.45 W/CFM for gas furnace air-handling units.

ii. 0.58 W/CFM for air-handling units that are not gas furnaces.

C. **Zonally controlled central forced air systems.** Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 cfm per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to the maximum W/CFM specified in Subsections i or ii below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

i. 0.45 W/CFM for gas furnace air-handling units.

ii. 0.58 W/CFM for air-handling units that are not gas furnaces.

D. **Small duct high velocity forced air systems.** Demonstrate, in every control mode, airflow greater than or equal to 250 CFM per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to 0.62 W/CFM as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

Exception 1 to Section 150.0(m)13B and D: Standard ducted systems (without zoning dampers) may comply by meeting the applicable requirements in Table 150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 150.0(m)12Div for the system air filter(s) shall conform to the requirements given in Tables 150.0-B and 150.0-C.

Exception 2 to Section 150.0(m)13B and D: Multispeed compressor systems or variable speed compressor systems shall verify air flow (cfm/ton) and fan efficacy (Watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

Exception 3 to Section 150.0(m)13B: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

Exception 1 to Section 150.0(m)13C: Multispeed or variable speed compressor systems, with controls that vary fan speed subject to the number of zones, as certified by the installer, may demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 150.0(m)13C by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning.

Exception 2 to Section 150.0(m)13C: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

(n) **Water heating system.**

1. Systems using gas or propane water heaters to serve individual dwelling units shall designate a space at least 2.5 feet by 2.5 feet wide and 7 feet tall suitable for the future installation of a heat pump water heater (HPWH) by meeting either A or B below. All electrical components shall be installed in accordance with the *California Electrical Code:*

A. If the designated space is within 3 feet from the water heater, then this space shall include the following:

i. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, branch circuit rated at 30 amps minimum, within 3 feet from the water heater and accessible to the water heater with no obstructions; and

ii. Both ends of the unused conductor shall be labeled with the word “spare” and be electrically isolated; and

iii. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in A above and labeled with the words “Future 240V Use”; and

iv. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance.

B. If the designated space is more than 3 feet from the water heater, then this space shall include the following:

i. A dedicated 240 volt branch circuit shall be installed within 3 feet from the designated space. The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as “240V ready”; and

ii. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future HPWH installation. The reserved space shall be permanently marked as “For Future 240V use”; and

iii. Either a dedicated cold water supply, or the cold water supply shall pass through the designated HPWH location just before reaching the gas or propane water heater; and

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iv. The hot water supply pipe coming out of the gas or propane water heater shall be routed first through the designated HPWH location before serving any fixtures; and

v. The hot and cold water piping at the designated HPWH location shall be exposed and readily accessible for future installation of an HPWH; and

vi. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance.

2. Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or by a listing agency that is approved by the executive director.

3. Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)6.

(o) **Requirements for ventilation and indoor air quality.** All dwelling units shall meet the requirements of ASHRAE Standard 62.2. Ventilation and Acceptable Indoor Air Quality in Residential Buildings subject to the amendments specified in Section 150.0(o)1 below. All dwelling units shall comply with Section 150.0(o)2 below.

Exception to Section 150.0(o): The following sections of ASHRAE 62.2 shall not be required for compliance: Section 4.1.1, Section 4.1.2, Section 4.1.4, Section 4.3, Section 4.6, Section 5, Section 6.1.1, Section 6.1.3 and Normative Appendix A.

1. Amendments to ASHRAE 62.2 requirements.

A. **Window operation.** Window operation is not a permissible method of providing the dwelling unit ventilation airflow specified in Section 150.0(o)1C below.

B. **Central fan integrated (CFI) ventilation systems.** CFI ventilation systems shall meet the following requirements.

i. **Continuous operation prohibition.** Continuous operation of a dwelling unit's central forced air system air handlers used in CFI ventilation systems is not a permissible method of providing the whole-dwelling unit ventilation airflow required in Section 150.0(o)1C.

ii. **Outdoor air damper(s)**. A motorized damper(s) shall be installed on the connected ventilation duct(s) of CFI systems that prevents all airflow into or out of the space-conditioning duct system when the damper(s) is closed.

iii. **Damper control**. The required motorized damper(s) shall be controlled to be in an opened position when outdoor air ventilation is required for compliance, and shall be in the closed position when ventilation air is not required. The damper(s) shall be closed whenever the space-conditioning system air handling unit is not operating. If the outdoor airflow for the CFI ventilation system is fan-powered, then the outdoor air fan shall not operate when the required motorized damper(s) on the outdoor air ventilation duct(s) is closed.

iv. **Variable ventilation.** CFI ventilation systems shall incorporate controls that track outdoor air ventilation run time, and either open or close the required motorized damper(s) depending on whether or not outdoor air ventilation is required for compliance with Section 150.0(o)1C. During periods when comfort conditioning is not called for by the space-conditioning thermostat, the CFI ventilation system controls shall operate the space-conditioning system central fan and outdoor air damper(s) when necessary to ensure compliance with the minimum outdoor air ventilation required by Section 150.0(o) in accordance with applicable variable mechanical ventilation methods specified in ASHRAE 62.2 Section 4.5.

C. **Whole-dwelling unit mechanical ventilation for single-family dwellings.** Single-family dwellings shall have mechanical ventilation as specified in Subsections i and iv. Single-family detached dwelling units and attached dwelling units not sharing ceilings or floors with other dwelling units, occupiable spaces, public garages, or commercial spaces may reduce their required mechanical ventilation rates in accordance with Subsections ii and iii. Vertically attached dwelling units shall not reduce their minimum ventilation rates in accordance with Subsections ii and iii.

i. Total Required Ventilation Rate [ASHRAE 62.2:4.1.1].

The total required ventilation rate shall be calculated using Equation 150.0-B.

(Equation 150.0-B) $Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$

where:

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

ii. **Effective Annual Average Infiltration Rate.** The effective annual average infiltration rate shall be determined in accordance with Subsections a and b:

a. An enclosure leakage rate in cubic feet per minute at 50 Pa (0.2 inch water) (Q_{50}) shall be determined by either Subsection 1 or Subsection 2 below.

1. Q_{50} shall be calculated based on the conditioned volume of the dwelling unit and a default value for dwelling unit envelope leakage of 2 air changes per hour at 50 PA (0.2 inch water) (2 ACH_{50}) as specified by Equation 150.0-C below.

(Equation 150.0-C) $Q_{50} = V_{du}$ x 2 ACH_{50}/60 min

where:

Q_{50} = leakage rate at 50 Pa.

V_{du} = dwelling unit conditioned volume, ft^3.

ACH_{50} = air changes per hour at 50 Pa (0.2 inch water).

2. If dwelling unit envelope leakage less than 2 ACH_{50} is confirmed by field verification and diagnostic testing, Q_{50} shall be calculated according to Equation 150.0-D below, using the value for dwelling unit envelope leakage less than 2 ACH_{50} verified by the procedures specified in Reference Residential Appendix RA3.8.

(Equation 150.0-D) $Q_{50} = V_{du} \times Verified\ ACH_{50}/60\ min$

where:

Q_{50} = leakage rate at 50 Pa.

V_{du} = dwelling unit conditioned volume, ft^3.

ACH_{50} = air changes per hour at 50 Pa (0.2 inch water).

b. The Effective Annual Average Infiltration Rate (Q_{inf}) shall be calculated using Equation 150.0-E [ASHRAE 62.2:4.1.2.1].

(Equation 150.0-E) $Q_{inf} = 0.052 \times Q_{50} \times wsf \times [H/H_r]^z$

where:

Q_{inf} = effective annual infiltration rate, cfm (L/s).

Q_{50} = leakage rate at 50 Pa from Equation 150.0-C or Equation 150.0-D.

wsf = weather and shielding factor from Table 150.0-D.

H = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m).

H_r = reference height, 8.2 ft (2.5 m).

z = 0.4 for the purpose of calculating the Effective Annual Average Infiltration Rate.

TABLE 150.0-B—RETURN DUCT SIZING FOR SINGLE RETURN DUCT SYSTEMS

Return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.
Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

SYSTEM NOMINAL COOLING CAPACITY (Ton)*	RETURN DUCT MINIMUM NOMINAL DIAMETER (inch)	MINIMUM TOTAL RETURN FILTER GRILLE NOMINAL AREA ($inch^2$)
1.5	16	500
2.0	18	600
2.5	20	800

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton.

TABLE 150.0-C—RETURN DUCT SIZING FOR MULTIPLE RETURN DUCT SYSTEMS

Each return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.
Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 12.5 Pa (0.05 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

SYSTEM NOMINAL COOLING CAPACITY (Ton)*	RETURN DUCT 1 MINIMUM NOMINAL DIAMETER (inch)	RETURN DUCT 2 MINIMUM NOMINAL DIAMETER (inch)	MINIMUM TOTAL RETURN FILTER GRILLE NOMINAL AREA ($inch^2$)
1.5	12	10	500
2.0	14	12	600
2.5	14	14	800
3.0	16	14	900
3.5	16	16	1000
4.0	18	18	1200
5.0	20	20	1500

*Not applicable to systems with nominal cooling capacity greater than 5.0 tons or less than 1.5 tons.

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TABLE 150.0-D—INFILTRATION EFFECTIVENESS WEATHER AND SHIELDING FACTORS [ASHRAE 62.2:TABLE B1]					
TMY3	**WSF**	**WEATHER STATION**	**LATITUDE**	**LONGITUDE**	**STATE**
690150	0.50	Twentynine Palms	34.30	–116.17	California
722860	0.43	March AFB	33.90	–117.25	California
722868	0.45	Palm Springs Intl	33.83	–116.50	California
722869	0.42	Riverside Muni	33.95	–117.45	California
722880	0.39	Burbank–Glendale–Pasadena AP	34.20	–118.35	California
722885	0.39	Santa Monica Muni	34.02	–118.45	California
722886	0.39	Van Nuys Airport	34.22	–118.48	California
722895	0.55	Lompoc (AWOS)	34.67	–120.47	California
722897	0.51	San Luis Co Rgnl	35.23	–120.63	California
722899	0.45	Chino Airport	33.97	–117.63	California
722900	0.38	San Diego Lindbergh Field	32.73	–117.17	California
722903	0.39	San Diego/Montgomery	32.82	–117.13	California
722904	0.40	Chula Vista Brown Field NAAS	32.58	–116.98	California
722906	0.39	San Diego North Island NAS	32.70	–117.20	California
722926	0.40	Camp Pendleton MCAS	33.30	–117.35	California
722927	0.38	Carlsbad/Palomar	33.13	–117.28	California
722930	0.39	San Diego Miramar NAS	32.87	–117.13	California
722950	0.42	Los Angeles Intl Arpt	33.93	–118.40	California
722956	0.38	Jack Northrop Fld H	33.92	–118.33	California
722970	0.38	Long Beach Daugherty Fld	33.83	–118.17	California
722976	0.34	Fullerton Municipal	33.87	–117.98	California
722977	0.36	Santa Ana John Wayne AP	33.68	–117.87	California
723805	0.51	Needles Airport	34.77	–114.62	California
723810	0.59	Edwards AFB	34.90	–117.87	California
723815	0.58	Daggett Barstow–Daggett AP	34.85	–116.80	California
723816	0.62	Lancaster Gen Wm Fox Field	34.73	–118.22	California
723820	0.57	Palmdale Airport	34.63	–118.08	California
723830	0.68	Sandberg	34.75	–118.72	California
723840	0.43	Bakersfield Meadows Field	35.43	–119.05	California
723890	0.45	Fresno Yosemite Intl AP	36.78	–119.72	California
723895	0.42	Porterville (AWOS)	36.03	–119.07	California
723896	0.43	Visalia Muni (AWOS)	36.32	–119.40	California
723910	0.45	Point Mugu Nf	34.12	–119.12	California
723925	0.44	Santa Barbara Municipal AP	34.43	–119.85	California
723926	0.43	Camarillo (AWOS)	34.22	–119.08	California
723927	0.45	Oxnard Airport	34.20	–119.20	California
723940	0.52	Santa Maria Public Arpt	34.92	–120.47	California
723965	0.53	Paso Robles Municipal Arpt	35.67	–120.63	California
724800	0.55	Bishop Airport	37.37	–118.35	California
724815	0.46	Merced/Macready Fld	37.28	–120.52	California
724830	0.51	Sacramento Executive Arpt	38.50	–121.50	California
724837	0.45	Beale AFB	39.13	–121.43	California
724838	0.50	Yuba Co	39.10	–121.57	California
724839	0.51	Sacramento Metropolitan AP	38.70	–121.58	California
724915	0.49	Monterey Naf	36.60	–121.87	California
724917	0.54	Salinas Municipal AP	36.67	–121.60	California
724920	0.50	Stockton Metropolitan Arpt	37.90	–121.23	California
724926	0.47	Modesto City–County AP	37.63	–120.95	California
724927	0.53	Livermore Municipal	37.70	–121.82	California
724930	0.54	Oakland Metropolitan Arpt	37.72	–122.22	California
724935	0.47	Hayward Air Term	37.67	–122.12	California
724936	0.53	Concord–Buchanan Field	38.00	–122.05	California

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TABLE 150.0-D—INFILTRATION EFFECTIVENESS WEATHER AND SHIELDING FACTORS [ASHRAE 62.2:TABLE B1]—continued					
TMY3	**WSF**	**WEATHER STATION**	**LATITUDE**	**LONGITUDE**	**STATE**
724940	0.60	San Francisco Intl AP	37.62	–122.40	California
724945	0.48	San Jose Intl AP	37.37	–121.93	California
724955	0.55	Napa Co. Airport	38.22	–122.28	California
724957	0.49	Santa Rosa (AWOS)	38.52	–122.82	California
725845	0.44	Blue Canyon AP	39.30	–120.72	California
725846	0.66	Truckee–Tahoe	39.32	–120.13	California
725847	0.64	South Lake Tahoe	38.90	–120.00	California
725905	0.47	Ukiah Municipal AP	39.13	–123.20	California
725910	0.50	Red Bluff Municipal Arpt	40.15	–122.25	California
725920	0.47	Redding Municipal Arpt	40.52	–122.32	California
725945	0.56	Arcata Airport	40.98	–124.10	California
725946	0.60	Crescent City Faa Ai	41.78	–124.23	California
725955	0.55	Montague Siskiyou County AP	41.78	–122.47	California
725958	0.59	Alturas	41.50	–120.53	California
745090	0.45	Mountain View Moffett Fld NAS	37.40	–122.05	California
745160	0.67	Travis Field AFB	38.27	–121.93	California
746120	0.52	China Lake Naf	35.68	–117.68	California
747020	0.50	Lemoore Reeves NAS	36.33	–119.95	California
747185	0.46	Imperial	32.83	–115.58	California
747187	0.46	Palm Springs Thermal AP	33.63	–116.17	California
747188	0.48	Blythe Riverside Co Arpt	33.62	–114.72	California

iii. Required Mechanical Ventilation Rate [ASHRAE 62.2:4.1.2]

The Required Mechanical Ventilation Rate (Q_{fan}) shall be calculated using Equation 150.0-F.

(Equation 150.0-F) $Q_{fan} = Q_{tot} - \Phi(Q_{inf} \times A_{ext})$

where:

Q_{fan} = required mechanical ventilation rate, cfm (L/s).

Q_{tot} = total required ventilation rate, cfm (L/s) from Equation 150.0-B.

Q_{inf} = effective annual average infiltration rate, cfm (L/s) from Equation 150.0-E.

A_{ext} = 1 for single-family detached homes, or the ratio of exterior envelope surface area that is not attached to garages or other dwelling units to total envelope surface area for attached dwelling units not sharing ceilings or floors with other dwelling units, occupiable spaces, public garages, or commercial spaces.

Φ = 1 for balanced ventilation systems and Q_{inf}/Q_{tot} otherwise.

iv. **Requirements for balanced and supply-only ventilation systems.**

a. IAQ filter and HRV/ERV accessibility: System air filters and HRV/ERV heat/energy recovery cores shall be located such that they are accessible for service from within occupiable spaces, basements, garages, balconies, and mechanical closets. Filters and heat/energy cores behind access panels, access doors, or grilles located not more than 10 feet above a walking surface inside a space specified above comply with this requirement.

Exception to Section 150.0(o)1Civa: Systems that require servicing from inside the attic shall have the following:

1. A fault indicator display (FID) meeting the requirements of Reference Appendix JA17.
2. An attic access door located in a wall or, where attic access is provided through a ceiling, an attic access hatch that includes an integrated ladder.
3. A walkway from the attic access door to the HRV/ERV.

b. IAQ system component accessibility: Fans, motors, heat exchangers, filters and recovery cores shall meet all applicable requirements of *California Mechanical Code* Section 304.0 accessibility for service.

c. Outdoor air intake design: Outdoor air intakes shall comply with *California Mechanical Code* Section 402.4.1.

d. Outdoor air intake location and accessibility: To provide access for cleaning, outdoor air intakes shall be accessible. Air intakes located not more than 10 feet above a walking surface comply with this requirement. If located on roofs, they shall meet the requirements of *California Mechanical Code* Section 304.3.1.

Exception to Section 150.0(o)1Civd: Outdoor air intake serving equipment with an FID meeting the requirements of Reference Appendix JA17.

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D. **Air filtration.** Air filtration shall conform to the specifications in Section 150.0(m)12. Compliance with ASHRAE 62.2 Sections 6.7 (Minimum Filtration) and 6.7.1 (Filter Pressure Drop) shall not be required.

E. **Reserved.**

F. **Reserved.**

G. **Local mechanical exhaust.** A local mechanical exhaust system shall be installed in each kitchen and bathroom. Systems shall be rated for airflow in accordance with ASHRAE 62.2 Section 7.1.

i. **Nonenclosed kitchens** shall have a demand-controlled mechanical exhaust system meeting the requirements of Section 150.0(o)1Giii.

ii. **Enclosed kitchens and all bathrooms** shall have either one of the following alternatives a or b:

a. A demand-controlled mechanical exhaust system meeting the requirements of Section 150.0(o)1Giii.

b. A continuous mechanical exhaust system meeting the requirements of Section 150.0(o)1Giv.

iii. **Demand-controlled mechanical exhaust.** A local mechanical exhaust system shall be designed to be operated as needed.

a. **Control and operation.** Demand-controlled mechanical exhaust systems shall be provided with at least one of the following controls:

1. A readily accessible occupant-controlled ON-OFF control.

2. An automatic control that does not impede occupant ON control.

b. **Ventilation rate and capture efficiency.** The system shall meet or exceed either the minimum airflow in accordance with Table 150.0-E or the minimum capture efficiency in accordance with Table 150.0-E, and Table 150.0-G. Capture efficiency ratings shall be determined in accordance with ASTM E3087 and listed in a product directory approved by the Energy Commission.

TABLE 150.0-E—DEMAND-CONTROLLED LOCAL VENTILATION EXHAUST AIRFLOW RATES AND CAPTURE EFFICIENCY

APPLICATION	COMPLIANCE CRITERIA
Enclosed Kitchen or Nonenclosed Kitchen	Vented range hood, including appliance-range hood combinations, shall meet either the capture efficiency (CE) or the airflow rate specified in Table 150.0-G as applicable.
Enclosed Kitchen or Nonenclosed Kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s)
Bathroom	50 cfm (25 L/s)

iv. **Continuous mechanical exhaust.** A mechanical exhaust system shall be installed to operate continuously. The system may be part of a balanced mechanical ventilation system.

a. **Control and operation**. A manual ON-OFF control shall be provided for each continuous mechanical exhaust system. The system shall be designed to operate during all occupiable hours. The ON-OFF control shall be accessible to the dwelling unit occupant.

b. **Ventilation rate.** The minimum delivered ventilation shall be at least the amount indicated in Table 150.0-F during each hour of operation.

TABLE 150.0-F—CONTINUOUS LOCAL VENTILATION EXHAUST AIRFLOW RATES

APPLICATION	AIRFLOW
Enclosed kitchen	5 ACH, based on kitchen volume
Bathroom	20 cfm (10 L/s)

TABLE 150.0-G—KITCHEN RANGE HOOD AIRFLOW RATES (CFM) AND ASTM E3087 CAPTURE EFFICIENCY (CE) RATINGS ACCORDING TO DWELLING UNIT FLOOR AREA AND KITCHEN RANGE FUEL TYPE

DWELLING UNIT FLOOR AREA (ft^2)	HOOD OVER ELECTRIC RANGE	HOOD OVER NATURAL GAS RANGE
>1500	50% CE or 110 cfm	70% CE or 180 cfm
>1000–1500	50% CE or 110 cfm	80% CE or 250 cfm
750–1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm

v. **Airflow measurement of local mechanical exhaust by the system installer.** The airflow required by Section 150.0(o)1G is the quantity of indoor air exhausted by the ventilation system as installed in the dwelling unit. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with Section

150.0(o)1Giiib, the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be met by the installed system. The as-installed airflow shall be verified by the system installer to ensure compliance by use of either Subsection a or b below:

a. The system installer shall measure the airflow by using a flow hood, flow grid or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Residential Appendix RA3.7.

b. As an alternative to performing an airflow measurement of the system as installed in the dwelling unit, compliance may be demonstrated by installing an exhaust fan and duct system that conforms to the specifications of Table 150.0-H. Visual inspection shall verify the installed system conforms to the requirements of Table 150.0-H.

When using Table 150.0-H for demonstrating compliance, the airflow rating shall be greater than or equal to the value required by Section 150.0(o)1G at a static pressure greater than or equal to 0.25 in. of water (62.5 Pa). When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with Section 150.0(o)1Giiib, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 150.0-H for determining compliance.

Use of Table 150.0-H is limited to ventilation systems that conform to all of the following three specifications:

1. Total duct length is less than or equal to 25 ft (8 m),
2. Duct system has no more than three elbows, and
3. Duct system has exterior termination fitting with a hydraulic diameter greater than or equal to the minimum duct diameter and not less than the hydraulic diameter of the fan outlet.

TABLE 150.0-H PRESCRIPTIVE VENTILATION SYSTEM DUCT SIZING [ASHRAE 62.2:TABLE 5-3]

FAN AIRFLOW RATING, cfm AT MINIMUM STATIC PRESSURE[f], 0.25 in. WATER (L/s at minimum 62.5 Pa)	MINIMUM DUCT DIAMETER FOR RIGID DUCT, in.(mm) [a,b]	MINIMUM DUCT DIAMETER FOR FLEX DUCT[c], in. (mm) [a,b]
≤50 (25)	4[e] (100)	4 (100)
≤80 (40)	5 (125)	5 (125)
≤100 (50)	5 (125)	6 (150)
≤125 (60)	6 (150)	6 (150)
≤150 (70)	6 (150)	7 (150)
≤175 (85)	7 (180)	7 (180)
≤200 (95)	7 (180)	8 (205)
≤250 (120)	8 (205)	8 (205)
≤350 (165)	9 (230)	9 (230)
≤400 (190)	10 (255)	10 (255)
≤450 (210)	10 (255)	NP
≤700 (330)	12 (305)	NP
≤800 (380)	12[d] (305)	NP

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.
b. NP = application of the prescriptive table is not permitted for this scenario.
c. Use of this table for verification of flex duct systems requires flex duct to be fully extended and any flex duct elbows to have a minimum bend radius to duct diameter ratio of 1.0.
d. For this scenario, use of elbows is not permitted.
e. For this scenario, 4 in. (100 mm) oval duct shall be permitted, provided the minor axis of the oval is greater than or equal to 3 in. (75 mm)
f. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 150.0(o)1Giiib, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 150.0-H for determining compliance.

vi. **Sound ratings for local mechanical exhaust.** Local mechanical exhaust systems shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 150.0(o)1G.

Exception to Section 150.0(o)1Gvi: Kitchen range hoods may be rated for sound at no less than 100 cfm at a static pressure determined at working speed as specified in HVI 916 section 7.2.

H. **Airflow measurement of whole-dwelling unit ventilation.** The airflow required by Section 150.0(o)1C is the quantity of outdoor ventilation air supplied or indoor air exhausted by the mechanical ventilation system as installed and shall be measured by using a flow hood, flow grid or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Residential Appendix RA3.7. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows.

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I. **Sound ratings for whole-dwelling unit ventilation systems.** Whole-dwelling unit ventilation systems shall be rated for sound in accordance with Section 7.3 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 150.0(o)1C.

J. **Label for whole-dwelling unit ventilation system on-off control.** Compliance with ASHRAE 62.2 Section 4.4 (Control and Operation) shall require manual ON-OFF control switches associated with whole-dwelling unit ventilation systems to have a label clearly displaying the following text, or equivalent text: "This switch controls the indoor air quality ventilation for the home. Leave switch in the 'on' position at all times unless the outdoor air quality is very poor."

K. **Combustion air and compensating outdoor air or makeup air.**

i. All dwelling units shall conform to the applicable requirements specified in *California Mechanical Code* Chapter 7, Combustion Air.

ii. All dwelling units shall conform to the requirements in ASHRAE 62.2 Section 6.4, Combustion and Solid-Fuel-Burning Appliances.

2. **Field verification and diagnostic testing.**

A. **Whole-dwelling unit ventilation airflow performance.** The whole-dwelling unit ventilation airflow required by Section 150.0(o)1C shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to comply with the required ventilation airflows.

B. **Kitchen local mechanical exhaust—vented range hoods**. Vented range hoods installed to comply with local mechanical exhaust requirements specified in Section 150.0(o)1G shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.7.4.3 to confirm the model is rated by HVI or AHAM to comply with the following requirements:

i. The minimum ventilation airflow rate as specified by Section 150.0(o)1G, or alternatively the minimum capture efficiency as specified by Section 150.0(o)1G.

ii The maximum sound rating as specified in Section 150.0(o)1Gvi.

C. **Heat recovery ventilation (HRV) and energy recovery ventilation (ERV) system fan efficacy.** Systems with heat or energy recovery serving a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm as confirmed by field verification in accordance with Reference Appendix RA3.7.4.4.

(p) **Pool systems and equipment installation.** Pool system or equipment shall comply with the applicable requirements of Section 110.4, as well as the requirements listed in this section.

1. **Pump sizing and flow rate for single-family buildings.**

A. Dedicated-purpose pool pumps and replacement dedicated-purpose pump motors subject to State or federal appliance standards shall be listed in the Commission's directory of certified equipment. Dedicated-purpose pool pumps shall meet the applicable standards set forth in 20 CCR §1605.1(g)(7) of the Appliance Efficiency Regulations. Replacement dedicated-purpose pool pump motors shall meet the applicable standards set forth in 20 CCR §1605.3 of the Appliance Efficiency Regulations;

B. All pump flow rates shall be calculated using the following system equation:

$H = C \times F^2$

where:

H - is the total system head in feet of water.

F - is the flow rate in gallons per minute (gpm).

C - is a coefficient based on the volume of the pool:

0.0167 for pools less than or equal to 17,000 gallons.

0.0082 for pools greater than 17,000 gallons.

C. Filtration pumps shall be sized, or if programmable shall be programmed, so that the filtration flow rate is not greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater; and

D. Dedicated-purpose pool pumps with more than one speed shall have controls which default to the filtration flow rate when no auxiliary pool loads are operating; and

E. For dedicated-purpose pool pumps with more than one speed, the controls shall default to the filtration flow rate setting within 24 hours and shall have an override capability for servicing.

2. **System piping.**

A. A length of straight pipe that is greater than or equal to at least 4 pipe diameters shall be installed before the pump; and

B. Pool piping shall be sized so that the velocity of the water at maximum flow for auxiliary pool loads does not exceed 8 feet per second in the return line and 6 feet per second in the suction line; and

C. All elbows shall be sweep elbows or of an elbow- type that has a pressure drop of less than the pressure drop of straight pipe with a length of 30 pipe diameters.

3. **Filters.** Filters shall be at least the size specified in NSF/ANSI 50 for public pool intended applications.
4. **Valves.** Minimum diameter of backwash valves shall be 2 inches or the diameter of the return pipe, whichever is greater.

(q) **Fenestration products.** Fenestration, including skylight products, separating conditioned space from unconditioned space or outdoors shall have a maximum weighted average *U*-factor of 0.40.

Exception 1 to Section 150.0(q): Up to 10 square feet of fenestration area or 0.5 percent of the conditioned floor area, whichever is greater, is not required to comply with the maximum *U*-factor requirement.

Exception 2 to Section 150.0(q): For dual-glazed greenhouse or garden windows, up to 30 square feet of fenestration area is not required to comply with the maximum *U*-factor requirement.

Exception 3 to Section 150.0(q): Fenestration installed in buildings meeting Part 7 of the *California Building Code, California Wildland-Urban Interface Code*, where the building is located in Fire Hazard Severity Zones or Wildland-Urban Interface (WUI) Fire Areas as designated by the local enforcement agency.

(r) **Solar ready buildings.** shall meet the requirements of Section 110.10 applicable to the building project.

(s) **Battery Energy Storage Systems (BESS) ready.** All single-family residences that include one or two dwelling units, which a load-serving entity provides with electrical service for the dwelling unit that is greater than 125 amps, shall meet the following.

1. At least one of the following shall be provided:
   A. BESS-ready interconnection equipment with a minimum backed-up capacity of 60 amps and a minimum of four BESS-supplied branch circuits specified in Section 150.0(s)2, or
   B. A dedicated raceway from the main service to a panelboard (subpanel) that supplies the branch circuits in Section 150.0(s)2. All branch circuits are permitted to be supplied by the main service panel prior to the installation of a BESS. The trade size of the raceway shall be not less than 1 inch. The panelboard that supplies the branch circuits (subpanel) must be labeled "Subpanel shall include all backed-up load circuits."
2. A minimum of four branch circuits shall be identified and have their source of supply collocated at a single panelboard suitable to be supplied by the BESS. At least one circuit shall supply the refrigerator, one lighting circuit shall be located near the primary egress and at least one circuit shall supply a sleeping room receptacle outlet.
3. The main panelboard shall have a minimum busbar rating of 225 amps.
4. Sufficient space shall be reserved to allow future installation of a system isolation equipment/transfer switch within 3 feet of the main panelboard. Raceways shall be installed between the panelboard and the system isolation equipment/transfer switch location to allow the connection of backup power source.

Exception to Section 150.0(s): Buildings which have a BESS installed.

(t) **Heat pump space heater ready.** Systems using gas or propane furnace to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the furnace and accessible to the furnace with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future heat pump space heater installation. The reserved space shall be permanently marked as "For Future 240V use."

(u) **Electric cooktop ready.** Systems using gas or propane cooktop to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the cooktop and accessible to the cooktop with no obstructions. The branch circuit conductors shall be rated at 50 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric cooktop installation. The reserved space shall be permanently marked as "For Future 240V use."

(v) **Electric clothes dryer ready.** Clothes dryer locations with gas or propane plumbing to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the clothes dryer location and accessible to the clothes dryer location with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric clothes dryer installation. The reserved space shall be permanently marked as "For Future 240V use."

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

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SUBCHAPTER

8

SINGLE-FAMILY RESIDENTIAL BUILDINGS—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 150.1—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR SINGLE-FAMILY RESIDENTIAL BUILDINGS

(a) **Basic requirements.** Single-family residential buildings shall meet all of the following:

1. The applicable requirements of Sections 110.0 through 110.10.
2. The applicable requirements of Section 150.0 (mandatory features).
3. Either the performance standards or the prescriptive standards set forth in this section for the climate zone in which the building is located. Climate zones are shown in Reference Joint Appendix JA2–Weather/Climate Data.

   Exception to Section 150.1(a)3: If a single contiguous subdivision or tract falls in more than one climate zone, all buildings in the subdivision or tract may be designed to meet the performance or prescriptive standards for the climate zone that contains 50 percent or more of the dwelling units.

   Note: The Commission periodically updates, publishes, and makes available to interested persons and local enforcement agencies precise descriptions of the climate zones, as specified in Reference Joint Appendix JA2–Weather/Climate Data.

Note: The requirements of Sections 150.0(a) through 150.0(r) apply to newly constructed buildings and Sections 150.2(a) and 150.2(b) specifies changes to the requirements of Sections 150.1(a) through 150.1(c) that apply to additions or alterations.

(b) **Performance approach.** A building complies with the performance approach if the energy consumption calculated for the proposed design building is no greater than the energy budget calculated for the standard design building using Commission-certified compliance software as specified by Sections 10-109(c) and 10-116.

1. **Energy budget.** The energy budget is expressed in terms of source energy and long-term system cost (LSC).
   - **A. Long-term system cost (LSC).** The LSC energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building and has two components, the Efficiency LSC and the Total LSC.
     - i. The Efficiency LSC energy is the sum of the LSC energy for space-conditioning, water heating, mechanical ventilation, and the self-utilization credit.
     - ii. The Total LSC energy is the sum of the Efficiency LSC energy and LSC energy from the photovoltaic system, battery energy storage systems (BESS), lighting, demand flexibility, and other plug loads.
   - **B. Source energy.** The source energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building. The source energy is the total annual source energy.

   Exception to Section 150.1(b)1. A community shared solar electric generation system, or other renewable electric generation system, or community shared BESS, which provides dedicated power, utility energy reduction credits, or payments for energy bill reductions to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system and demand flexibility Energy Design Rating required to comply with the Standards, as calculated according to methods established by the Commission in the Residential ACM Reference Manual.

2. **Compliance demonstration requirements for performance standards.**
   - A. **Certificate of compliance and application for a building permit.** The application for a building permit shall include documentation pursuant to Sections 10-103(a)1 and 10-103(a)2 which demonstrates, using an approved calculation method, that the building has been designed so that its energy consumption does not exceed the standard design energy budgets for the applicable climate zone.

     Exception to Section 150.1(b)2A Multiple orientation: A permit applicant may demonstrate compliance with the energy budget requirements of Section 150.1(a) and (b) for any orientation of the same building model if the documentation demonstrates that the building model with its proposed designs and features would comply in each of the four cardinal orientations.
   - B. **Field verification.** When performance of installed features, materials, components, manufactured devices or systems above the minimum specified in Section 150.1(c) is necessary for the building to comply with Section 150.1(b), or is necessary to achieve a more stringent local ordinance, field verification shall be performed in accordance with the applicable requirements in the following subsections, and the results of the verification(s) shall be documented on applicable certificates of installation pursuant to Section 10-103(a)3 and applicable certificates of verification pursuant to Section 10-103(a)5.
     - i. **EER2/SEER2/CEER/HSPF2 Rating.** When performance compliance requires installation of a space-conditioning system with a rating that is greater than the minimum rating required by Table 150.1-A or specified for the standard design, the installed system shall be field verified in accordance with the procedures specified in the applicable sections of Reference Residential Appendix RA3.4.
     - ii. **Variable capacity heat pump (VCHP) compliance option.** When performance compliance requires installation of a heat pump system that meets all the requirements of the VCHP compliance option specified in the ACM

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Reference Manual, the system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.4.3.

iii. **Low leakage air handler.** When performance compliance requires installation of a low leakage air-handling unit, the installed air-handling unit shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9.

iv. **Reserved.**

v. **Heat pump—rated heating capacity.** When performance compliance requires installation of a heat pump system, the heating capacity values at 47°F and 17°F shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.

vi. **Whole-house fan.** When performance compliance requires installation of a whole-house fan, the whole-house fan ventilation airflow rate and fan efficacy shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.9.

vii. **Central fan ventilation cooling system.** When performance compliance requires installation of a central fan ventilation cooling system, the installed system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.3.4.

viii. **Building enclosure air leakage.** When performance compliance requires a building enclosure leakage rate that is lower than the standard design, the building enclosure shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.8.

ix. **Quality Insulation Installation (QII).** When performance compliance requires field verification of QII, the building insulation system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.5.

(c) **Prescriptive standards/component packages.** Buildings that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements for the appropriate climate zone shown in Table 150.1-A. In Table 150.1-A, an NA (not allowed) means that feature is not permitted in a particular climate zone and an NR (no requirement) means that there is no prescriptive requirement for that feature in a particular climate zone. Installed components shall meet the following requirements:

1. **Insulation.**

A. Roof and ceiling insulation shall be installed with an *R*-value equal to or greater than that shown in Table 150.1-A meeting Option i, ii or iii below.

i. Option A: **Reserved.**

ii. Option B: A minimum *R*-value of insulation in a ventilated attic installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9A; or

iii. Option C: A minimum *R*-value of ceiling insulation located between a ventilated attic and the conditioned space or within a cathedral ceiling assembly shall comply with Section 150.1(c)9B.

B. **Walls.**

i. Framed exterior walls shall be insulated such that the exterior wall has an assembly *U*-factor equal to or less than that shown in Table 150.1-A. The *U*-factors shown are maximum *U*-factors for the exterior wall assembly.

ii. Mass walls above grade and below grade shall be insulated such that the wall has an assembly *U*-factor equal to or less than that shown in Table 150.1-A, or walls shall be insulated with continuous insulation that has an *R*-value equal to or greater than that shown in Table 150.1-A. "Interior" denotes continuous insulation installed on the inside surface of the wall, and "exterior" denotes continuous insulation installed on the outside surface of the wall.

iii. Other unframed exterior walls, excluding mass walls, shall meet the requirements for framed walls shown in Table 150.1-A.

C. Raised floors shall be insulated such that the floor assembly has an assembly *U*-factor equal to or less than shown in Table 150.1-A, or shall be insulated between wood framing with insulation having an *R*-value equal to or greater than that shown in Table 150.1-A.

Exception to Section 150.1(c)1C: Raised-floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in Table 150.1-A, and a vapor retarder is placed over the entire floor of the crawl space, and the vents are fitted with automatically operated louvers, and the requirements of Reference Residential Appendix RA4.5.1 are met.

D. Slab floor perimeter insulation shall be installed with a *U*-factor equal to or less than, or *R*-value equal to or greater than, shown in Table 150.1-A. The minimum depth of concrete-slab floor perimeter insulation shall be 16 inches or the depth of the footing of the building, whichever is less.

Exception to Section 150.1(c)1: The insulation requirements of Table 150.1-A may also be met by ceiling, roof deck, wall, or floor assemblies that meet the required maximum *U*-factors using a *U*-factor calculation method that considers the thermal effects of all elements of the assembly and is approved by the executive director.

E. All buildings shall comply with the quality insulation installation (QII) requirements shown in Table 150.1-A. When QII is required, insulation installation shall meet the criteria specified in Reference Appendix RA3.5.

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2. **Radiant barrier.** A radiant barrier required in Table 150.1-A shall meet the requirements specified in Section 110.8(j) and shall meet the installation criteria specified in the Reference Residential Appendix RA4.
3. **Fenestration.**
   A. Installed fenestration products, including glazed doors, shall have an area weighted average *U*-factor and Solar Heat Gain Coefficient (SHGC) meeting the applicable fenestration value in Table 150.1-A and shall be determined in accordance with Sections 110.6(a)2 and 110.6(a)3.

      Exception 1 to Section 150.1(c)3A: New dwelling units with a conditioned floor area of 500 square feet or less in Climate Zone 5 may comply with a maximum *U*-factor of 0.30.

      Exception 2 to Section 150.1(c)3A: For each dwelling unit, up to 3 square feet of new glazing area installed in doors and up to 3 square feet of tubular skylights area with dual-pane diffusers shall not be required to meet the *U*-factor and SHGC requirements of Table 150.1-A.

      Exception 3 to Section 150.1(c)3A: In Climate Zones 2, 4, and 6 through 15, for each dwelling unit up to 16 square feet of skylight area with a maximum *U*-factor of 0.40 and a maximum SHGC of 0.30. In Climate Zones 1, 3, 5, and 16, there is no SHGC requirement.

      Exception 4 to Section 150.1(c)3A: For fenestration containing chromogenic type glazing:

      i. The lower-rated labeled *U*-factor and SHGC shall be used with automatic controls to modulate the amount of solar gain and light transmitted into the space in multiple steps in response to daylight levels or solar intensity;

      ii. Chromogenic glazing shall be considered separately from other fenestration; and

      iii. Area-weighted averaging with other fenestration that is not chromatic shall not be permitted and shall be determined in accordance with Section 110.6(a).

      Exception 5 to Section 150.1(c)3A: For dwelling units containing unrated site-built fenestration that meets the maximum area restriction, the *U*-factor and SHGC can be determined in accordance with the Nonresidential Reference Appendix NA6 or use default values in Table 110.6-A and Table 110.6-B.

   B. The maximum total fenestration area shall not exceed the percentage of conditioned floor area CFA as indicated in Table 150.1-A. Total fenestration includes skylights and west-facing glazing.

   C. The maximum west-facing fenestration area shall not exceed the percentage of conditioned floor area as indicated in Table 150.1-A. West-facing fenestration area includes skylights tilted in any direction when the pitch is less than 1:12.
4. **Shading.** Where Table 150.1-A requires a maximum SHGC, the shading requirements shall be met by one of the following:
   A. Complying with the required maximum SHGC pursuant to Section 150.1(c)3A, or

   B. An exterior operable shading louver or other exterior shading device that meets the required maximum SHGC; or

   C. A combination of Items A and B to achieve the same performance as achieved in Section 150.1(c)3A.

   D. For south-facing glazing only, optimal overhangs shall be installed so that the south-facing glazing is fully shaded at solar noon on August 21 and substantially exposed to direct sunlight at solar noon on December 21.

   E. Exterior shading devices must be permanently secured with attachments or fasteners that are not intended for removal.

      Exception to Section 150.1(c)4E: Where the *California Building Code* (CBC) requires emergency egress or where compliance would conflict with health and safety regulations.
5. **Doors.** Installed swinging door products separating conditioned space from outside or adjacent unconditioned space, but not including glazed door products, shall have an area-weighted average U-factor no greater than the applicable door value in Table 150.1-A and shall be determined in accordance with Section 110.6(a)2. Glazed door products are treated as fenestration products in Sections 150.1(c)3 and 150.1(c)4.

   Exception to Section 150.1(c)5: Swinging doors between the garage and conditioned space that are required to have fire protection are not required to meet the applicable door value in Table 150.1-A.
6. **Heating system type.** Heating system types shall be installed as required in Table 150.1-A. The space-conditioning system shall be a heat pump, or shall meet the performance compliance requirements of Section 150.1(b)1.

   Exception to Section 150.1(c)6: A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kW or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.
7. **Space heating and space cooling.** All space heating and space cooling equipment shall comply with minimum appliance efficiency regulations as specified in Sections 110.0 through 110.2 and meet all applicable requirements of Sections 150.0 and 150.1(c)7A.
   A. **Refrigerant charge.** When refrigerant charge verification is shown as required by Table 150.1-A, the system shall comply with either Section 150.1(c)7Ai or 150.1(c)7Aii:

      i. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems, and mini-split systems, shall comply with Subsections a, b and c, unless the system is of a type that cannot be verified using the specified procedures:

         a. Have measurement access holes (MAH), installed according to the specifications in Reference Residential Appendix Section RA3.2.2.3; and

Exception to Section 150.1(c)7Aia: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.2-1, shall not be required to provide holes as described in Figure RA3.2-1.

b. System airflow rate in accordance with Subsection I or II shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix Section RA3. 3 or an approved alternative procedure as specified by Section RA1; and

I. For small duct high velocity systems the system airflow rate shall be greater than or equal to 250 cfm per ton; or

II. For all other air-cooled air conditioner or air-source heat pump systems the system airflow rate shall be greater than or equal to 350 cfm per ton.

Exception to Section 150.1(c)7Aib: Standard ducted systems without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in Table 150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 150.0(m)12D for the system air filter device(s) shall conform to the requirements given in Tables 150.0-B and 150.0-C.

c. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable:

I. The installer and rater shall perform the standard charge procedure as specified by Reference Residential Appendix Section RA3.2.2, or an approved alternative procedure as specified by Section RA1; or

II. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1 provided the system is of a type that can be verified using the Section RA3.2.2 standard charge verification procedure and Section RA3.3 airflow rate verification procedure or approved alternatives in Section RA1. The ECC-Rater shall verify the charge using Sections RA3.2.2 and RA3.3 or approved alternatives in Section RA1.

Exception 1 to Section 150.1(c)7Aic: When the outdoor temperature is less than 55°F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to verify the refrigerant charge, the installer may elect to utilize the verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.1(c)7Aib.

ii. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high-velocity systems and mini-split systems, which are of a type that cannot be verified using the specified procedures, with the requirements of Section 150.1(c)7Ai shall comply with Subsections a and b, as applicable.

a. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix Section RA3.2.3.1, as verified by an ECC-Rater according to the procedures specified in Reference Residential Appendix Section RA3.2.3.2.; and

b. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 150.1(c)7Aib provided the system is of a type that can be verified using the procedures in Section RA3.3 or an approved alternative procedure in Section RA1.

Exception 1 to Section 150.1(c)7A: Packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirements in Section 150.1(c)7Aib, provided that the system is of a type that can be verified using the procedure specified in Section RA3.3 or an approved alternative in Section RA1.

8. **Domestic water-heating systems.** Water-heating systems shall meet the requirements of A, B or C, or shall meet the performance compliance requirements of Section 150.1(b)1. For recirculation distribution systems, only demand recirculation systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be used:

A. A single 240 volt heat pump water heater (HPWH). The storage tank shall be located in the garage or conditioned space. In addition, meet the following:

i. A compact hot water distribution system that is field verified as specified in the Reference Appendix RA4.4.6 in Climate Zones 1 and 16; and

ii. A drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 in Climate Zone 16.

B. A single 240 volt HPWH that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher. In addition, for Climate Zone 16, a drain water heat recovery system that is field verified as specified in Reference Appendix RA3.6.9 and the storage tank shall be located in the garage or conditioned space.

C. A solar water-heating system with electric backup meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum annual solar savings fraction of 0.7.

Exception 1 to Section 150.1(c)8: An electric water heater with point of use distribution as specified in RA4.4.5 may be installed for new dwelling units with a conditioned floor area of 500 square feet or less.

Exception 2 to Section 150.1(c)8A and B: A 120V HPWH may be installed in place of a 240V HPWH for new dwelling unit with one bedroom or fewer.

9. **Space-conditioning distribution systems.** All space-conditioning systems shall meet all applicable requirements of A or B below:

A. High performance attics. Air handlers or ducts are allowed to be in ventilated attic spaces when the roof and ceiling insulation level meet Option B in Table 150.1-A. Duct insulation levels shall meet the requirements in Table 150.1-A.

B. Duct systems and air handlers of HVAC systems shall be located entirely in conditioned space and confirmed through field verification and diagnostic testing to meet the criterion of Reference Residential Appendix Section RA3.1.4.3.8. Duct insulation levels shall meet the requirements in Table 150.1-A. For dwelling units with attics, the duct system and air handlers of HVAC systems shall be located below the ceiling separating the occupiable space from the attic.

Note: Gas heating appliances installed in conditioned spaces must meet the combustion air requirements of the *California Mechanical Code* Chapter 7, as applicable.

10. **Central fan integrated ventilation systems.** Central forced air system fans used to provide outside air shall have an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in A, B or C. The airflow rate and fan efficacy requirements in this section shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.3. Central fan integrated ventilation systems shall be certified to the Energy Commission as intermittent ventilation systems as specified in Reference Residential Appendix RA3.7.4.2.

A. 0.45 W/cfm for gas furnace air-handling units.

B. 0.58 W/cfm for air-handling units that are not gas furnaces.

C. 0.62 W/cfm for small-duct high-velocity air-handling units.

Exception to Section 150.1(c)10A: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

11. **Roofing products.** All roofing products shall meet the requirements of Section 110.8 and the applicable requirements of Subsection A or B:

A. Single-family residential buildings with steep-sloped roofs in climate zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

B. Single-family residential buildings with low-sloped roofs, in climate zones 13 and 15 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75 or a minimum SRI of 75.

Exception 1 to Section 150.1(c)11: Building integrated photovoltaic panels and building integrated solar thermal panels are not required to comply with the minimum requirements for aged solar reflectance and thermal emittance or SRI.

Exception 2 to Section 150.1(c)11: Roof constructions with a weight of at least 25 lb/ft^2 are not required to comply with the minimum requirements for aged solar reflectance and thermal emittance or SRI.

12. **Ventilation cooling.** Single-family homes shall comply with the whole-house fan (WHF) requirements shown in Table 150.1-A. When a WHF is required, comply with Subsections A, B and C below.

A. Have installed one or more WHFs whose total airflow cfm is equal to or greater than 1.5 cfm/ft^2 of conditioned floor area. Airflow cfm for WHFs shall be determined based on the airflow listed in the Home Ventilating Institute Certified Products Directory.

B. Have at least 1 square foot of attic vent free area for each 750 cfm of rated whole-house fan airflow cfm, or if the manufacturer has specified a greater free vent area, the manufacturer's free vent area specifications.

Exception to Section 150.1(c)12B: WHFs that are directly vented to the outside.

C. Provide homeowners who have WHFs with a one page "How to operate your whole-house fan" informational sheet.

Exception to Section 150.1(c)12: New dwelling units with a conditioned floor area of 500 square feet or less shall not be required to comply with the WHF requirements.

13. **HVAC system bypass ducts.** Bypass ducts that deliver conditioned supply air directly to the space-conditioning system return duct airflow shall not be used.

14. **Photovoltaic requirements.** All single-family residential buildings shall have a newly installed photovoltaic (PV) system or newly installed PV modules meeting the minimum qualification requirements specified in Joint Appendix JA11. The annual electrical output of the PV system shall be no less than the smaller of a PV system size determined using Equation 150.1-C, or the total solar access roof area (SARA) multiplied by 18 for steep-sloped roofs or multiplied by 14 for low-sloped roofs.

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A. SARA includes the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.10.

B. SARA does NOT include:

i. Any roof area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation, accounting for shading obstructions, by the total annual solar insolation if the same areas were unshaded by obstructions. For steep slope roofs, only shading from existing permanent natural or manmade obstructions that are external to the dwelling, including but not limited to trees, hills, and adjacent structures, shall be considered for annual solar access calculations. For low slope roofs, all obstructions, including those that are external to the dwelling unit, and obstructions that are part of the building design and elevation features shall be considered for the annual solar access calculations.

ii. Occupied roof areas as specified by CBC Section 503.1.4.

iii. Roof area that is otherwise not available due to compliance with:

a. Other state building code requirements, or

b. Local building code requirements if local building code requirements are confirmed by the Executive Director.

EQUATION 150.1-C—ANNUAL PHOTOVOLTAIC ELECTRICAL OUTPUT

$kW_{PV} = (CFA \times A)/1000 + (N_{DU} \times B)$

where:

kW_{PV} = kW_{dc} size of the PV system.

CFA = Conditioned floor area.

N_{DU} = Number of dwelling units.

A = CFA adjustment factor from Table 150.1-C.

B = Dwelling unit adjustment factor from Table 150.1-C.

Exception 1 to Section 150.1(c)14: For steep slope roofs, SARA shall not consider roof areas with a northerly azimuth that lies between 300 degrees and 90 degrees from true north. No PV system is required if the SARA is less than 80 contiguous square feet.

Exception 2 to Section 150.1(c)14: No PV system is required when the minimum PV system size specified by Section 150.1(c)14 is less than 1.8 kW_{dc}.

Exception 3 to Section 150.1(c)14: Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules and components and supports and attachments to the roof structure, to meet the requirements of the American Society of Civil Engineers (ASCE), Standard 7-16, Chapter 7, Snow Loads.

Exception 4 to Section 150.1(c)14: For buildings that are approved by the local planning department prior to January 1, 2020 with mandatory conditions for approval:

a. Shading from roof designs and configurations for steep-sloped roofs, which are required by the mandatory conditions for approval, shall be considered for the annual solar access calculations; and

b. Roof areas that are not allowed by the mandatory conditions for approval to have PVs shall not be considered in determining the SARA.

Exception 5 to Section 150.1(c)14: PV system sizes determined using Equation 150.1-C may be reduced by 25 percent if installed in conjunction with a BESS. The BESS shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum cycling capacity of 7.5 kWh as defined in Joint Appendix JA12.

15. Ventilation system fault indicator display (FID): All HRV/ERV systems serving individual dwelling units shall have a fault indicator display (FID) that is ECC-Rater field verified as specified in Joint Appendix JA17.

TABLE 150.1-A COMPONENT PACKAGE—SINGLE-FAMILY STANDARD BUILDING DESIGN

BUILDING COMPONENT ROOFS AND CEILINGS	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Option B[13] Below Roof Deck Insulation[1,2] (with Air Space)	NR	NR	NR	R-19	NR	NR	NR	R-19	R-19	R-19	R-19	R-19	R-19	R-19	R-19	R-19
Option B[13] Ceiling Insulation	R-38	R-38	R-30	R-38	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Option B[13] Radiant Barrier	NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
Option C[14] Ceiling Insulation for Vented Attics	R-38	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Option C[14] Radiant Barrier for Vented Attics	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Option C Roof Deck Insulation for Cathedral Ceilings[1,4]	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Low-Sloped Roofing Product Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
Low-Sloped Roofing Product Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
Steep-Sloped Roofing Product Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
Steep-Sloped Roofing Product Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
Above Grade Framed Walls[3]	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.065	U-0.065	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048
Above Grade Masonry/ Mass Wall Interior[5,6]	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.059 R-17
Above Grade Masonry/ Mass Wall Exterior[4,5,6]	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.125 R-8.0	U-0.077 R-13
Below Grade Interior Walls[7]	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.077 R-13	U-0.067 R-15
Below Grade Exterior Walls[7]	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.200 R-5.0	U-0.100 R-10	U-0.100 R-10	U-0.053 R-19
Slab Perimeter Floors	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	F0.58 R 7.0
Raised Floors	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19
Concrete Raised Floors	U-0.092 R-8.0	U-0.092 R-8.0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.269 R-0	U-0.092 R-8.0	U-0.138 R-4.0	U-0.092 R-8.0	U-0.092 R-8.0	U-0.138 R-4.0	U-0.092 R-8.0
Fenestration - Maximum *U*-factor[12]	0.27	0.27	0.27	0.27	0.27	0.30	0.30	0.30	0.30	0.30	0.27	0.27	0.27	0.27	0.30	0.27
Fenestration - Maximum SHGC	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.20~~3~~	NR
Fenestration - Maximum Total Area	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Fenestration - Maximum West Facing Area	NR	5%	NR	5%	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
Door - Maximum *U*-Factor	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Quality Insulation Installation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Space Heating - Electric Resistance Allowed	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Space Heating - If gas, AFUE[10]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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TABLE 150.1-A COMPONENT PACKAGE—SINGLE-FAMILY STANDARD BUILDING DESIGN—continued

BUILDING COMPONENT ROOFS AND CEILINGS	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Space Heating - If Heat Pump, HSPF2[8]	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Space Cooling -SEER2	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Space Cooling - Whole-House Fan[9]	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	NR
Refrigerant Charge Verification Air Conditioners	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Refrigerant Charge Verification Heat Pumps	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Central Fan Integrated Ventilation System - Fan Efficacy	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Option B[13] Roof/Ceiling - Duct Insulation	R-8	R-8	R-6	R-8	R-6	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
Option B[13] - §150.1(c)9A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Option C[14] Roof/Ceiling - Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6
Option C[11, 14] - §150.1(c)9B	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
FID required if HRV/ERV Systems Installed	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Water Heating -150.1(c)8	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ

1. Install the specified *R*-value with an air space present between the roofing and the roof deck, such as standard installation of concrete or clay tile.
2. *R*-values shown for below roof deck insulation are for wood-framed construction with insulation installed between the framing members. Alternatives including insulation above rafters or above roof deck shall comply with the performance standards.
3. Assembly *U*-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly *U*-factor equal to or less than the *U*-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to be less than or equal to the required maximum *U*-factor.
4. Assembly *U*-factors for roofs can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly *U*-factor equal to or less than the *U*-factor shown. Use Reference Joint Appendices JA4 Table 4.2.2 to determine alternative insulation products to be less than or equal to the required maximum *U*-factor. *R*-values shown represent the required insulation to meet the maximum *U*-factor with cavity insulation alone.
5. Mass wall has a heat capacity greater than or equal to 7.0 Btu/h-ft^2.
6. "Interior" denotes insulation installed on the inside surface of the wall. "Exterior" denotes insulation installed on the exterior surface of the wall.
7. Below grade "interior" denotes insulation installed on the inside surface of the wall, and below grade "exterior" denotes insulation installed on the outside surface of the wall.
8. HSPF2 means heating seasonal performance factor.
9. When whole-house fans are required (REQ), only those whole-house fans that are listed in the Home Ventilating Institute Certified Products Directory may be installed. Compliance requires installation of one or more WHFs whose total airflow cfm is capable of meeting or exceeding a minimum 1.5 cfm/square foot of conditioned floor area as specified by Section 150.1(c)12.
10. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/h and is controlled by a time-limiting device not exceeding 30 minutes.
11. For duct and air handler location: REQ denotes location in conditioned space. When the table indicates ducts and air handlers are in conditioned space, a verification is required as specified by Reference Residential Appendix RA3.1.4.3.8.
12. New dwelling units with a conditioned floor area of 500 square feet or less in Climate Zone 5 may comply with a maximum *U*-factor of 0.30.
13. Option B meets §150.1(c)9A.
14. Option C meets §150.1(c)9B.

TABLE 150.1-B—RESERVED

TABLE 150.1-C—CFA AND DWELLING UNIT ADJUSTMENT FACTORS		
CLIMATE ZONE	**A—CFA**	**B—DWELLING UNITS**
1	0.793	1.27
2	0.621	1.22
3	0.628	1.12
4	0.586	1.21
5	0.585	1.06
6	0.594	1.23
7	0.572	1.15
8	0.586	1.37
9	0.613	1.36
10	0.627	1.41
11	0.836	1.44
12	0.613	1.40
13	0.894	1.51
14	0.741	1.26
15	1.56	1.47
16	0.59	1.22

Note: Authority: Sections 25213, 25218, 25218.5, 25402, 25402.1, and 25605, *Public Resources Code.* Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25605, and 25943, *Public Resources Code.*

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SUBCHAPTER

9

SINGLE-FAMILY RESIDENTIAL BUILDINGS—ADDITIONS AND ALTERATIONS TO EXISTING RESIDENTIAL BUILDINGS

SECTION 150.2—ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS TO EXISTING SINGLE-FAMILY RESIDENTIAL BUILDINGS

(a) **Additions.** Additions to existing single-family residential buildings shall meet the requirements of Sections 110.0 through 110.9; Sections 150.0(a) through (n), (p) and (q); and either Section 150.2(a)1 or 2.

Exception 1 to Section 150.2(a): Additions of 300 square feet or less are not required to comply with the roofing requirements of Section 150.1(c)11.

Exception 2 to Section 150.2(a): Existing inaccessible piping shall not require insulation as defined under Section 150.0(j)1.

Exception 3 to Section 150.2(a): Space-conditioning system. When heating or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Part 6. The heating system capacity must be adequate to meet the minimum requirements of CRC 303.10.

Exception 4 to Section 150.2(a): Space-conditioning system ducts. When any length of duct is extended from an existing duct system to serve the addition, the existing duct system and the extended duct shall meet the applicable requirements specified in Section 150.2(b)1Di and 150.2(b)1Dii.

Exception 5 to Section 150.2(a): Additions 1,000 square feet or less are not required to comply with the ventilation cooling requirements of Section 150.1(c)12.

Exception 6 to Section 150.2(a): Photovoltaic systems, as specified in Section 150.1(c)14, are not required for additions.

1. **Prescriptive approach.** Additions to existing buildings shall meet the following additional requirements:
   - A. Additions that are greater than 700 square feet shall meet the requirements of Section 150.1(c), with the following modifications:
     - i. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2 × 4 framing and R-21 in a 2 × 6 framing.
     - ii. The maximum allowed fenestration area shall be the greater of 175 square feet or 20 percent of the addition floor area, and the maximum allowed west-facing fenestration area shall be the greater of 70 square feet or the requirements of Section 150.1(c).
     - iii. Alterations that add fenestration area shall have a maximum SHGC value of 0.23 in Climate Zone 15.
     - iv. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2 × 4 framing and R-21 in a 2 × 6 framing shall be installed and continuous insulation is not required.
     - v. Additions that consist of the conversion of existing spaces from unconditioned to conditioned space shall not be required to perform the following as part of QII:
       - a. Existing window and door headers shall not be required to be insulated.
       - b. Air sealing shall not be required when the existing air barrier is not being removed or replaced.
   - B. Additions that are 700 square feet or less shall meet the requirements of Section 150.1(c), with the following modifications:
     - i. Roof and ceiling insulation in a ventilated attic shall meet one of the following requirements:
       - a. In Climate Zones 1, 2, 4, and 8 through 16, achieve an overall assembly *U*-factor not exceeding 0.025. In wood framed assemblies, compliance with *U*-factors may be demonstrated by installing insulation with an *R*-value of R-38 or greater.
       - b. In Climate Zones 3, and 5 through 7, achieve an overall assembly *U*-factor not exceeding 0.031. In wood framed assemblies, compliance with *U*-factors may be demonstrated by installing insulation with an *R*-value of R-30 or greater.
     - ii. Radiant barriers shall be installed in Climate Zones 2-15.
     - iii. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2 × 4 framing and R-21 in a 2 × 6 framing.
     - iv. In Climate Zones 2, 4 and 6-15; the maximum allowed west-facing fenestration area shall not be greater than 60 square feet; and shall also comply with either a or b below:
       - a. For additions that are 700 square feet or less but greater than 400 square feet, the maximum allowed fenestration area limit is the greater of 120 square feet or 25 percent of the conditioned floor area of the addition.
       - b. For additions that are 400 square feet or less, the maximum allowed fenestration area is the greater of 75 square feet or 30 percent of the conditioned floor area of the addition.
     - v. Quality Insulation Installation (QII) requirements of Section 150.1(c)1E do not apply.
     - vi. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2 × 4 framing and R-21 in a 2 × 6 framing shall be installed and continuous insulation is not required.

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Exception to Section 150.2(a)1B: Insulation in an enclosed rafter ceiling shall meet the requirements of Section 150.0.

C. **Mechanical ventilation for indoor air quality.** Additions to existing buildings shall comply with Section 150.0(o) subject to the requirements specified in Subsections i and ii below.

i. **Whole-dwelling unit mechanical ventilation.**

a. Dwelling units that meet the conditions in Subsection 1 or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F.

1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

2. Junior accessory dwelling units (JADU) that are additions to an existing building.

b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

c. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

ii. **Local mechanical exhaust.** Additions to existing buildings shall comply with all applicable requirements specified in Sections 150.0(o)1G and 150.0(o)2.

D. **Water heater.** When an additional water heater is installed as part of the addition, one of the following types of water heaters shall be installed:

i. A single heat pump water heater. The storage tank shall not be located outdoors and shall be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that either meets the requirements of Section 110.12(a) or has an ANSI/CTA-2045-B communication port; or

ii. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher; or

iii. For additions that are 500 square feet or less, an electric water heater with point of use distribution as specified in RA4.4.5; or

iv. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item i, ii or iii.

E. **Space-conditioning load calculations and system capacity.**

i. Minimum capacity limits and supplemental heating requirements are as described in Section 150.0(h).

ii. The maximum capacity depends on the relative sizes of the calculated design heating load (HL) and cooling load (CL), the type of space-conditioning system, and the duct sizing.

a. In situations where airflow is field verified to be at least 350 cfm/ton, there is no maximum capacity limit.

b. In situations where airflow is NOT field verified to be at least 350 cfm/ton, the system capacities shall be no larger than indicated in Table 150.2-A for heating and Table 150.2-B for cooling.

Exception 1 to Section 150.2(a)1Eii: Ductless space-conditioning systems.

Exception 2 to Section 150.2(a)1Eii: For variable-speed and multi-speed systems, if the maximum system capacity specified in Table 150.2-A or 150.2-B falls between two available system capacities for a space-conditioning system, the larger of the two available capacities may be selected.

iii. For additions, the envelope leakage specified in the load calculation shall be not greater than the values shown in Table 150.2-C.

Exception to Section 150.2(a)1Eiii: If leakage is established through field verification and diagnostic testing following procedures specified in Reference Residential Appendix RA3.8, the tested envelope leakage value may be used in the load calculations and no disclosure is required.

TABLE 150.2-A—MAXIMUM HEATING CAPACITY

SYSTEM TYPE	MAXIMUM HEATING CAPACITY FOR HEATING ONLY SYSTEMS	HEAT PUMP MAXIMUM HEATING CAPACITY WHEN HL IS GREATER THAN CL	HEAT PUMP MAXIMUM HEATING CAPACITY WHEN CL IS GREATER THAN HL BY LESS THAN 12 kBtu/h	HEAT PUMP MAXIMUM HEATING CAPACITY WHEN CL IS GREATER THAN HL BY 12 kBtu/h OR MORE
Single-Speed System Capacity	HL + 6 kBtu/h	No Maximum	HL + 12 kBtu/h	No Maximum
Variable- or Multi-Speed System Maximum Capacity	HL + 6 kBtu/h	No Maximum	HL + 12 kBtu/h	No Maximum
Variable- or Multi-Speed System Capacity at Lowest Speed	80% of HL	80% of HL	No Maximum	No Maximum

HL and CL refer to the design heating load and design cooling load, respectively.

TABLE 150.2-B—MAXIMUM COOLING CAPACITY				
SYSTEM TYPE	MAXIMUM COOLING CAPACITY FOR COOLING ONLY SYSTEMS	HEAT PUMP MAXIMUM COOLING CAPACITY WHEN HL IS GREATER THAN CL	HEAT PUMP MAXIMUM COOLING CAPACITY WHEN CL IS GREATER THAN HL BY LESS THAN 12 kBtu/h	HEAT PUMP MAXIMUM COOLING CAPACITY WHEN CL IS GREATER THAN HL BY 12 kBtu/h OR MORE
Single-Speed System Capacity	CL + 6 kBtu/h	No Maximum	CL + 6 kBtu/h	CL + 6 kBtu/h
Variable- or Multi-Speed System Maximum Capacity	CL + 6 kBtu/h	No Maximum	CL + 6 kBtu/h	CL + 6 kBtu/h
Variable- or Multi-Speed System Capacity at Lowest Speed	80% of CL	No Maximum	80% of CL	80% of CL
HL and CL refer to the design heating load and design cooling load, respectively.				

TABLE 150.2-C—MAXIMUM INFILTRATION AIR CHANGES PER HOUR FOR LOAD CALCULATIONS						
FLOOR AREA OF CONDITIONED SPACE	SINGLE-STORY HEATING	SINGLE-STORY COOLING	TWO-STORY HEATING	TWO-STORY COOLING	TOWNHOUSE OR CONDOMINIUM HEATING	TOWNHOUSE OR CONDOMINIUM COOLING
ACH for ≤ 900 ft^2	0.61	0.32	0.79	0.41	0.69	0.36
ACH for 901–1,500 ft^2	0.45	0.23	0.80	0.30	0.50	0.27
ACH for 1,501–2,000 ft^2	0.38	0.20	0.50	0.26	0.43	0.23
ACH for 2,001–3,000 ft^2	0.32	0.16	0.41	0.21	0.36	0.19
ACH for ≥ 3,001 ft^2	0.28	0.15	0.37	0.19	0.32	0.17
CFM for One Fireplace	20	0	20	0	20	0

2. **Performance approach.** The energy budget for additions is expressed in terms of long-term system cost (LSC). Performance calculations shall meet the requirements of Section 150.1(a) through (c), pursuant to the applicable requirements in Items A, B and C below.
   A. **For additions alone.** The addition complies if the addition alone meets the energy budgets as specified in Section 150.1(b).
   B. **Existing plus alteration plus addition.** The standard design for existing plus alteration plus addition energy use is the combination of the existing building's unaltered components to remain; existing building altered components that are the more efficient, in LSC energy, of either the existing conditions or the requirements of Section 150.2(b)2; plus the proposed addition's energy use meeting the requirements of Section 150.2(a)1. The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered components' energy features, plus the proposed energy features of the addition.

      Exception to Section 150.2(a)2B: Existing structures with a minimum R-11 insulation in framed walls showing compliance with Section 150.2(a)2 are not required to comply with Section 150.0(c).
   C. **Mechanical ventilation for indoor air quality.** Additions to existing buildings shall comply with Section 150.0(o) subject to the requirements specified in Subsections i and ii below.
      i. **Whole-dwelling unit mechanical ventilation.**
         a. Dwelling units that meet the conditions in Subsection 1 or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F.
            1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.
            2. Junior accessory dwelling units (JADU) that are additions to an existing building.
         b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.
         c. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.
      ii. **Local mechanical exhaust.** Additions to existing buildings shall comply with all applicable requirements specified in Sections 150.0(o)1G and 150.0(o)2.
   D. **Space-conditioning load calculations and system capacity.** Additions to existing buildings shall comply with all applicable requirements specified in Section 150.2(a)1E.

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(b) **Alterations.** Alterations to existing single-family residential buildings or alterations in conjunction with a change in building occupancy to a single-family residential occupancy shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110.0 through 110.9, all applicable requirements of Sections 150.0(a) through (l), 150.0(m)1 through 150.0 (m)10, and 150.0(p) through (q); and

   A. **Added fenestration.** Alterations that add vertical fenestration and skylight area shall meet the total fenestration area and west facing fenestration area, *U*-factor, and solar heat gain coefficient requirements of Section 150.1(c)3A and Table 150.1-A.

   Exception 1 to Section 150.2(b)1A: Alterations that increase fenestration area shall have a maximum SHGC value of 0.23 in Climate Zone 15.

   Exception 2 to Section 150.2(b)1A: Alterations that add up to 16 square feet of new fenestration or skylight area shall not be required to meet the total fenestration area and west-facing fenestration area requirements of Sections 150.1(c)3B and C.

   B. **Replacement fenestration.** New manufactured fenestration products installed to replace existing fenestration products of the same total area shall meet the U-factor and Solar Heat Gain Coefficient requirements of Sections 150.1(c)3A, and 150.1(c)4.

   Exception 1 to Section 150.2(b)1B: Replacement of vertical fenestration no greater than 75 square feet with a *U*-factor no greater than 0.40 in Climate Zones 1–16, and a SHGC value no greater than 0.35 in Climate Zones 2, 4 and 6 through 15.

   Exception 2 to Section 150.2(b)1B: Replaced skylights must meet a *U*-factor no greater than 0.40, and a SHGC value no greater than 0.30.

   Exception 3 to Section 150.2(b)1B: Replacement of vertical fenestration shall have a maximum SHGC value not greater than 0.23 in Climate Zone 15.

   Note: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs, provided that the replacement is at least equivalent to the original in performance.

   C. **Entirely new or complete replacement space-conditioning systems** installed as part of an alteration, shall include all the system heating or cooling equipment, including but not limited to: condensing unit, cooling or heating coil, and air handler for split systems; or complete replacement of a packaged unit; plus entirely new or replacement duct system [Section 150.2(b)1Diia]. Entirely new or complete replacement space-conditioning systems shall meet the requirements of Sections 150.0(h), 150.0(i), 150.0(j)1, 150.0(j)2, 150.0(m)1 through 150.0(m)10, 150.0(m)12, 150.0(m)13, 150.1(c)7, 150.2(b)1Fii, 150.2(b)1G and Table 150.2-A.

   D. **Altered duct systems—duct sealing.** In all climate zones, when more than 25 feet of new or replacement space-conditioning system ducts are installed, the ducts shall comply with the applicable requirements of Subsections i and ii below. Additionally, when altered ducts, air-handling units, cooling or heating coils, or plenums are located in garage spaces, the system shall comply with Subsection 150.2(b)1Diic regardless of the length of any new or replacement space-conditioning ducts installed in the garage space.

      i. New ducts located in unconditioned space shall meet the applicable requirements of Sections 150.0(m)1 through 150.0(m)10, and the duct insulation requirements of Table 150.2-D; and

TABLE 150.2-D—DUCT INSULATION *R*-VALUE

Climate Zone	3, 5 through 7	1, 2, 4, 8 through 16
Duct *R*-Value	R-6	R-8

      ii. The altered duct system, regardless of location, shall be sealed as confirmed through field verification and diagnostic testing in accordance with all applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix Section RA3.1, utilizing the leakage compliance criteria specified in Subsection a or b below.

         a. **Entirely new or complete replacement duct system.** If the new ducts form an entirely new or complete replacement duct system directly connected to the air handler, the duct system measured leakage shall be equal to or less than 5 percent of the system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.

            Entirely new or complete replacement duct systems installed as part of an alteration is constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air handler, coil, plenums, duct material; if the reused parts are accessible and can be sealed to prevent leakage.

            Entirely new or complete replacement duct systems shall also conform to the requirements of Sections 150.0(m)12 and 150.0(m)13. If the air handler and ducts are located within a vented attic, the requirements of Section 150.2(b)1J shall also be met.

b. **Extension of an existing duct system.** If the new ducts are an extension of an existing duct system serving single-family dwellings, the combined new and existing duct system shall meet one of the following requirements:

I. The measured duct leakage shall be equal to or less than 10 percent of system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

II. The measured duct leakage to outside shall be equal to or less than 7 percent of system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

III. If it is not possible to meet the duct sealing requirements of either Section 150.2(b)1DiibI or 150.2(b)1DiibII, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified ECC-Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

Exception to Section 150.2(b)1Diib: Duct sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

c. **Altered ducts and duct system components in garage spaces.** When new or replacement space-conditioning ducts, air-handling units, cooling or heating coils, or plenums are located in a garage space, compliance with either I or II below is required.

I. The measured system duct leakage shall be less than or equal to 6 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

II. All accessible leaks located in the garage space shall be sealed and verified through a visual inspection and a smoke test by a certified ECC-Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

E. **Altered space-conditioning system—duct sealing.** In all climate zones, when a space-conditioning system serving a single-family dwelling is altered by the installation or replacement of space-conditioning system equipment, including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil, the duct system that is connected to the altered space-conditioning system equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1, and the leakage compliance criteria specified in Subsection i, ii, or iii below. Additionally, when altered ducts, air-handling units, cooling or heating coils, or plenums are located in garage spaces, the system shall comply with Section 150.2(b)1Diic regardless of the length of any new or replacement space-conditioning ducts installed in the garage space.

i. The measured duct leakage shall be equal to or less than 10 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix RA3.1.4.3.1; or

ii. The measured duct leakage to outside shall be equal to or less than 7 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

iii. If it is not possible to meet the duct sealing requirements of either Section 150.2(b)1Ei or 150.2(b)1Eii, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified ECC-Rater utilizing the methods specified in Reference Residential Appendix Section RA3.1.4.3.5.

Exception 1 to Section 150.2(b)1E: Duct sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.1.

Exception 2 to Section 150.2(b)1E: Duct sealing. Duct systems with less than 40 linear feet as determined by visual inspection.

Exception 3 to Section 150.2(b)1E: Duct sealing. Existing duct systems constructed, insulated or sealed with asbestos.

F. **Altered space-conditioning system—mechanical cooling.** When a space-conditioning system is an air conditioner or heat pump that is altered by the installation or replacement of refrigerant-containing system components such as the compressor, condensing coil, evaporator coil, refrigerant metering device or refrigerant piping, the altered system shall comply with the following requirements:

i. All thermostats associated with the system shall be replaced with setback thermostats meeting the requirements of Section 110.2(c).

ii. Air-cooled air conditioners in Climate Zones 2 and 8 through 15 and air-source heat pumps in all climate zones, including but not limited to ducted split systems, ducted package systems, small duct high-velocity air systems, and minisplit systems shall comply with Subsections a and b, unless the system is of a type that cannot be verified using the specified procedures. Systems that cannot comply with the requirements of Section 150.2(b)1Fii shall comply with Section 150.2(b)1Fiii.

Exception to Section 150.2(b)1Fii: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged

system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.2(b)1Fiia, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

a. Minimum system airflow rate shall comply with the applicable Subsection I or II below as confirmed through field verification and diagnostic testing in accordance with the procedures specified in Reference Residential Appendix Section RA3.3 or an approved alternative procedure as specified in Section RA1.

1. Small duct high-velocity systems shall demonstrate a minimum system airflow rate greater than or equal to 250 cfm per ton of nominal cooling capacity; or
2. All other air-cooled air conditioner or air-source heat pump systems shall demonstrate a minimum system airflow rate greater than or equal to 300 cfm per ton of nominal cooling capacity; and

Exception 1 to Section 150.2(b)1Fiia: Systems unable to comply with the minimum airflow rate requirement shall demonstrate compliance using the procedures in Section RA3.3.3.1.5; and the system's thermostat shall conform to the specifications in Section 110.12.

Exception 2 to Section 150.2(b)1Fiia: Entirely new or complete replacement space-conditioning systems, as specified by Section 150.2(b)1C, without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in Table 150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 150.0(m)12C for the system air filter device(s) shall conform to the requirements given in Tables 150.0-B and 150.0-C.

b. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable.

I. The installer and rater shall perform the standard charge verification procedure as specified in Reference Residential Appendix Section RA3.2.2, or an approved alternative procedure as specified in Section RA1; or

II. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1, provided the system is of a type that can be verified using the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate verification procedure or approved alternatives in RA1. The ECC-Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1.

Exception to Section 150.2(b)1Fiib: When the outdoor temperature is less than 55°F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to demonstrate compliance, the installer may elect to utilize the verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirements in Section 150.2(b)1Fiia.

iii. Air-cooled air conditioners in Climate Zones 2 and 8 through 15 and air-source heat pumps in all climate zones, including but not limited to ducted split systems, ducted package systems, small duct high-velocity, and mini-split systems, which are of a type that cannot comply with the requirements of 150.2(b)1Fiib shall comply with Subsections a and b, as applicable.

a. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix RA3.2.3.1, as verified by an ECC-Rater according to the procedures specified in Reference Residential Appendix RA3.2.3.2; and

b. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 150.2(b)1Fiia provided the system is of a type that can be verified using the procedures in Section RA3.3 or an approved alternative procedure in Section RA1.

Exception to Section 150.2(b)1Fiii: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.2(b)1Fiiib, provided that the system is of a type that can be verified using the procedure specified in Section RA3.3 or an approved alternative in Section RA1.

G. **Altered space-heating system.** Altered or replacement space-heating systems shall not use electric resistance as the primary heat source.

Exception 1 to Section 150.2(b)1G: Nonducted electric resistance space heating systems, if the existing space heating system is electric resistance.

Exception 2 to Section 150.2(b)1G: Ducted electric resistance space heating systems, if the existing space heating system is electric resistance and a ducted space cooling system is not being replaced or installed.

Exception 3 to Section 150.2(b)1G: Electric resistance space heating systems, if the existing space heating system is electric resistance and the building is located in Climate Zone 7 or 15.

H. **Water-heating system.** Altered or replacement service water-heating systems or components shall meet the applicable requirements below:

i. **Pipe insulation.** For newly installed and existing accessible piping, the insulation requirements of Section 150.0(j)1 shall be met.

ii. **Distribution system.** For recirculation distribution systems: serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be installed.

iii. **Water heating system.** The water heating system shall meet one of the following:

a. A natural gas or propane water-heating system; or

b. A single heat pump water heater. The storage tank shall not be located outdoors and be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that either meets the requirements of Section 110.12(a) or has an ANSI/CTA-2045-B communication port; or

c. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher; or

d. If the existing water heater is an electric resistance water heater, a consumer electric water heater; or

e. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item a above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the executive director to use no more energy than the one specified in Item d above.

I. **Roofs.** Replacements of the exterior surface of existing roofs, including adding a new surface layer on top of the existing exterior surface, shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i and ii where more than 50 percent of the roof is being replaced.

i. **Steep-sloped roofs.** Steep-sloped roofs shall meet the following:

New roofing products in Climate Zones 4 and 8 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

Exception 1 to Section 150.2(b)1Ii: The following shall be considered equivalent to Subsection i:

a. Buildings with ceiling assemblies with a *U*-factor lower than or equal to 0.025 or that are insulated with at least R-38 ceiling insulation; or

b. Buildings with a radiant barrier in the attic, where the radiant barrier is not installed directly above spaced sheathing, meeting the requirements of Section 150.1(c)2; or

c. In Climate Zones 2, 4, 9, 10, 12 and 14, buildings that have no ducts in the attic; or

d. Buildings with R-2 or greater continuous insulation above or below the roof deck.

Exception 2 to Section 150.2(b)1Ii: Roof area covered by building integrated photovoltaic panels or building integrated solar thermal panels is not required to meet minimum requirements for aged solar reflectance, thermal emittance or SRI.

Exception 3 to Section 150.2(b)1Ii: Roof constructions with a weight of at least 25 lb/ft^2 are not required to comply with the minimum requirements for aged solar reflectance and thermal emittance, or SRI.

ii. **Low-sloped roofs.** Low-sloped roofs shall meet the following:

a. New roofing products in Climate Zones 4 and 6 through 15 shall have an aged solar reflectance equal to or greater than 0.63 and a thermal emittance equal or greater than 0.75, or a minimum SRI of 75.

Exception 1 to Section 150.2(b)1Iiia: The aged solar reflectance can be met by using insulation at the roof deck specified in Table 150.2-E.

TABLE 150.2-E—AGED SOLAR REFLECTANCE INSULATION TRADE-OFF TABLE

MINIMUM AGED SOLAR REFLECTANCE	ROOF DECK CONTINUOUS INSULATION *R*-VALUE (Climate Zones 6–7)	ROOF DECK CONTINUOUS INSULATION *R*-VALUE (Climate Zones 2, 4 and 8–15)
0.60	2	16
0.55	4	18
0.50	6	20
0.45	8	22
No requirement	10	24

Exception 2 to Section 150.2(b)1Iiia: Roof area covered by building integrated photovoltaic panels or building integrated solar thermal panels is not required to meet the minimum requirements for aged solar reflectance, thermal emittance or SRI.

Exception 3 to Section 150.2(b)1Iiia: Roof constructions with a weight of at least 25 lb/ft^2 are not required to comply with the minimum requirements for aged solar reflectance and thermal emittance, or SRI.

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b. Roofs shall be insulated to the levels specified in Table 150.2-F.

TABLE 150.2-F—INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

CLIMATE ZONE	CONTINUOUS INSULATION *R*-VALUE	ROOF ASSEMBLY *U*-FACTOR
3, 5–7	N.A.	N.A.
1, 2, 4, 8–16	R-14	0.039

Exception 1 to Section 150.2(b)1Iiib: Existing roofs with R-10 or greater continuous insulation above or below the roof deck; or

Exception 2 to Section 150.2(b)1Iiib: Existing roofs with an assembly *U*-factor of 0.056 or less or that are insulated with at least R-19 insulation between the roof rafters and in contact with the roof deck in Climate Zones 1, 2, 4, and 8 through 10; or

Exception 3 to Section 150.2(b)1Iiib: The continuous insulation requirements of Table 150.2-F may be reduced to R-4 where the following conditions are met:

i. Mechanical equipment is located on the roof and will not be temporarily disconnected and lifted as part of the roof replacement and the addition of insulation required by Table 150.2-F would reduce the height from the roof surface to the top of the base flashing to less than that set forth in the manufacturer's installation instructions as per *California Residential Code* Section R900; or

ii. Replaced roofing abuts sidewall or parapet walls and the addition of insulation required by Table 150.2-F would reduce the height from the roof surface to the top of the base flashing to less than that set forth in the manufacturer's installation instructions as per *California Residential Code* Section R900, provided that the following conditions apply:

1. The sidewall or parapet walls are finished with an exterior cladding material other than the roof covering membrane material; and
2. The sidewall or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain the minimum base flashing height; and
3. The ratio of the replaced roof area to the linear dimension of affected sidewall or parapet walls is less than 25 square feet per linear foot; or

Exception 4 to Section 150.2(b)1Iiib: The continuous insulation requirements per Table 150.2-F may be reduced where increasing the thickness of above deck insulation would reduce the flashing around an existing exterior wall opening below what is permitted by the fenestration or door manufacturer's installation instructions, or registered design professional's approved flashing design, as per *California Residential Code* Section R703.4, or by *California Residential Code* Section R905.2.8.3.

Exception 5 to Section 150.2(b)1Biib: Tapered insulation with thermal resistance less than prescribed at the drains and other low points may be used provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the required value.

J. **Ceiling.** Vented attics shall meet the following:

i. In Climate Zones 1 through 4, 6, and 8 through 16 insulation shall be installed to achieve a weighted *U*-factor of 0.020 or insulation installed at the ceiling level shall result in an insulated thermal resistance of R-49 or greater for the insulation alone; and

Exception to Section 150.2(b)1Ji: In Climate Zones 1, 3 and 6, dwelling units with at least R-19 existing insulation installed at the ceiling level.

ii. In Climate Zones 2, 4, and 8 through 16, air seal all accessible areas of the ceiling plane between the attic and the conditioned space in accordance with Section 110.7; and

Exception 1 to Section 150.2(b)1Jii: Dwelling units with at least R-19 existing insulation installed at the ceiling level.

Exception 2 to Section 150.2(b)1Jii: Dwelling units with atmospherically vented space-heating or water-heating combustion appliances located inside the pressure boundary of the dwelling unit.

iii. In Climate Zones 1 through 4 and 8 through 16, recessed downlight luminaires in the ceiling shall be covered with insulation to the same depth as the rest of the ceiling. Luminaires not rated for insulation contact must be replaced or retrofitted with a fireproof cover that allows for insulation to be installed directly over the cover; and

Exception 1 to Section 150.2(b)1Jiii: In Climate Zones 1 through 4 and 8 through 10, dwelling units with at least R-19 existing insulation installed at the ceiling level.

iv. Attic ventilation shall comply with the *California Residential Code*, Title 24, Part 2.5, Section R806.

Exception 1 to Section 150.2(b)1J: Dwelling units with at least R-38 existing insulation installed at the ceiling level.

Exception 2 to Section 150.2(b)1J: Dwelling units where the alteration would directly cause the disturbance of asbestos.

Exception 3 to Section 150.2(b)1J: Dwelling units with knob and tube wiring located in the vented attic.

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Exception 4 to Section 150.2(b)1J: Where the accessible space in the attic is not large enough to accommodate the required *R*-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section 806.3 of Title 24, Part 2.5.

Exception 5 to Section 150.2(b)1J: Where the attic space above the altered dwelling unit is shared with other dwelling units and the requirements of Section 150.2(b)1J are not triggered for the other dwelling units.

K. **Lighting.** The altered lighting system shall meet the lighting requirements of Section 150.0(k). The altered luminaires shall meet the luminaire efficacy requirements of Section 150.0(k). Where existing screw-base sockets are present in ceiling-recessed luminaires, removal of these sockets is not required provided that new JA8-compliant trim kits or lamps designed for use with recessed downlights or luminaires are installed.

L. **Mechanical ventilation for indoor air quality—entirely new or complete replacement ventilation systems.** Entirely new or complete replacement ventilation systems shall comply with all applicable requirements in Section 150.0(o). An entirely new or complete replacement ventilation system includes a new ventilation fan component and an entirely new duct system. An entirely new or complete replacement duct system is constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air filtration devices and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

M. **Mechanical ventilation for indoor air quality—altered ventilation systems.** Altered ventilation system components or newly installed ventilation equipment serving the alteration shall comply with Section 150.0(o) as applicable subject to the requirements specified in Subsections i and ii below.

i. **Whole-dwelling unit mechanical ventilation.**

a. **Whole-dwelling unit airflow.** If the whole-dwelling ventilation fan is altered or replaced, then one of the following Subsections 1 or 2 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the whole-dwelling unit airflow requirements in Section 150.0(o) shall meet or exceed the whole-dwelling unit mechanical ventilation airflow specified in Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F as confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.
2. Dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F.

b. **Replacement ventilation fans.** Whole-dwelling unit replacement ventilation fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Sections 7.1 and 7.3. Additionally, when conformance to a specified whole-dwelling unit airflow rate is required for compliance, the replacement fans shall be rated at no less than the airflow rate required for compliance.

c. **Air filters.** If the air filtration device for a whole-dwelling unit ventilation system is altered or replaced, then one of the following Subsections 1 or 2 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the ventilation system air filtration requirements in Section 150.0(m)12 shall comply with the air filtration requirements in Section 150.0(m)12.
2. Dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in Section 150.0(m)12 shall not be required to comply with the air filtration requirements specified in Section 150.0(m)12.

ii. **Local mechanical exhaust.**

a. **Bathroom local mechanical exhaust.** Altered bathroom local mechanical exhaust systems shall comply with the applicable requirements specified in Section 150.0(o)1G.

b. **Kitchen local mechanical exhaust.** If the kitchen local ventilation fan is altered or replaced, then one of the following Subsections 1, 2 or 3 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in Section 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 150.0(o)1G.
2. Dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater.
3. Dwellings that were not required to have a kitchen local ventilation exhaust system according to the conditions in either Subsection 1 or 2 above shall not be required to comply with the requirements of Section 150.0(o)1G.

c. **Replacement ventilation fans.** New or replacement local mechanical exhaust fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Section 7.1 and Title 24, Part 6 Section 150.0(o)1Gvi. Additionally, when compliance with a specified exhaust airflow rate is required, the replacement fan shall be rated at no less than the airflow rate required for compliance.

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N. **Exterior doors.** Alterations that add exterior door area shall meet the *U*-factor requirement of Section 150.1(c)5.

2. **Performance approach.** The energy budget for alterations is expressed in terms of long-term system cost (LSC), and the altered component(s) and any newly installed equipment serving the alteration shall meet the applicable requirements of Subsections A, B, and C below.

A. The altered components shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 150.0(a) through (l), Sections 150.0(m)1 through 150.0 (m)10, and Sections 150.0(p) through (q). Entirely new or complete replacement mechanical ventilation systems, as these terms are used in Section 150.2(b)1L, shall comply with the requirements in Section 150.2(b)1L. Altered mechanical ventilation systems shall comply with the requirements of Section 150.2(b)1M. Entirely new or complete replacement space-conditioning systems, and entirely new or complete replacement duct systems, as these terms are used in Sections 150.2(b)1C and 150.2(b)1Diia, shall comply with the requirements of Sections 150.0(m)12 and 150.0(m)13.

B. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements stated in Table 150.2-G. For components not being altered, the standard design shall be based on the existing conditions. When the third party verification option is specified as a requirement, all components proposed for alteration for which the additional credit is taken must be verified by a certified ECC-Rater.

TABLE 150.2-G—STANDARD DESIGN FOR AN ALTERED COMPONENT

ALTERED COMPONENT	STANDARD DESIGN WITHOUT THIRD PARTY VERIFICATION OF EXISTING CONDITIONS SHALL BE BASED ON	STANDARD DESIGN WITH THIRD-PARTY VERIFICATION OF EXISTING CONDITIONS SHALL BE BASED ON
Ceiling insulation, wall insulation, and raised-floor insulation	The requirements of Sections 150.0(a), (c), and (d).	The existing insulation *R*-value.
Fenestration	The requirements of Section 150.1(c)3A.	The existing fenestration *U*-factor and SHGC values as verified.
Window film	The requirements of Section 150.1(c)3A.	The existing fenestration in the alteration shall be based on Tables 110.6-A and 110.6-B.
Doors	The *U*-factor of 0.20. The door area shall be the door area of the existing building.	If the proposed *U*-factor is < 0.20, the standard design shall be based on the existing *U*-factor value as verified. Otherwise, the standard design shall be based on the *U*-factor of 0.20. The door area shall be the door area of the existing building.
Space-heating and space-cooling equipment	Table 150.1-A for equipment efficiency requirements; Section 150.2(b)1C for entirely new or complete replacement systems; Section 150.2(b)1F for refrigerant charge verification requirements.	The existing efficiency levels.
Air distribution system – duct sealing	The requirements of Sections 150.2(b)1D and 150.2(b)1E	
Air distribution system – duct insulation	The proposed efficiency levels.	The existing efficiency levels.
Water heating systems	The requirements of Section 150.2(b)1Hii.	The existing efficiency levels.
Roofing products	The requirements of Section 150.2(b)1I.	
All other measures	The proposed efficiency levels.	The existing efficiency levels.

C. The proposed design shall be based on the actual values of the altered components.

Notes to Section 150.2(b)2:

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the standard design altered component energy budget and must meet the requirements of Section 150.2(b)2B.
2. The standard design shall assume the same geometry and orientation as the proposed design.
3. The "existing efficiency level" modeling rules, including situations where nameplate data are not available, are described in Sections 10-109(c) and 10-116.

Exception 1 to Section 150.2(b): Any dual- glazed greenhouse or/garden window installed as part of an alteration complies with the *U*-factor requirements in Section 150.1(c)3.

Exception 2 to Section 150.2(b): Where the space in the attic or rafter area is not large enough to accommodate the required *R*-value, the entire space shall be filled with insulation, provided such installation does not violate Section 1203.2 of Title 24, Part 2.

(c) **Whole building.** Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for the entire building.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25910, and 25943, *Public Resources Code*.

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CALIFORNIA MECHANICAL CODE, CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 4, CHAPTER 6, DUCT SYSTEMS

TABLE P4-A ADOPTION TABLE		
CODE SECTION		**AGENCY**
Adopt entire Chapter as amended (amended sections listed below)[1]		CEC
601.0		X
602.0		X
603.0		X
604.0		X
605.0		X
1. Adopted by reference for Occupancies A, B, E, F, H, M, R, S, and U; see Sections 110.8(d)3, 120.4 and 150.0(m).		

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SUBCHAPTER

10 MULTIFAMILY BUILDINGS—MANDATORY REQUIREMENTS

SECTION 160.0—GENERAL

Multifamily buildings shall comply with the applicable requirements of Sections 160.1 through 160.9. Sections 160.1 through 160.8 apply to dwelling units and common use areas in multifamily buildings. Nonresidential occupancies in a mixed occupancy building shall comply with nonresidential requirements in Sections 120.0 through 141.1.

NOTE: The requirements of Sections 160.1 through 160.9 apply to newly constructed buildings. Sections 180.1 through 180.4 specify which requirements of Sections 160.1 through 160.9 apply to additions or alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.1—MANDATORY REQUIREMENTS FOR BUILDING ENVELOPES

(a) **Ceiling and roof insulation.** The opaque portions of ceilings and roofs separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Item 1 or 2, and 3 below:

1. Attic roof. Roofs with an attic space shall meet the requirements of A through C below:
   A. Shall be insulated to achieve an area-weighted average *U*-factor not exceeding *U*-0.043 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-22 or greater for the insulation alone. For vented attics, the mandatory insulation shall be installed at the ceiling level; for unvented attics, the mandatory insulation shall be placed at either ceiling or roof level;
   B. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage; and
   C. When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled *R*-value.
2. Nonattic roof. Roofs without attic spaces shall meet the applicable requirements of A through C below:
   A. Metal building—The area-weighted average *U*-factor of the roof assembly shall not exceed 0.098.
   B. Wood framed and others—The area-weighted average *U*-factor of the roof assembly shall not exceed 0.075.
   C. Insulation placement—When insulation is installed at the roof, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed. When the space between the ceiling and the roof is either directly or indirectly conditioned space, it shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements.

   Exception to Section 160.1(a)2C: Vents that do not penetrate the roof deck and are instead designed for wind resistance for roof membranes are not within the scope of Section 160.1(a)2C.
3. Insulation shall be installed in direct contact with a roof or ceiling that is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.

(b) **Wall insulation.** Opaque portions of above grade walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the following applicable requirements:

1. Metal building—The area-weighted average *U*-factor of the wall assembly shall not exceed 0.113.
2. Metal framed—The area-weighted average *U*-factor of the wall assembly shall not exceed 0.151.
3. Wood framed and others—
   A. Nominal 2x4 inch framing shall have an area-weighted average *U*-factor of the wall assembly not exceeding 0.095.
   B. Nominal 2x6 inch framing shall have an area-weighted average *U*-factor of the wall assembly not exceeding 0.069.
   C. Other wall assemblies shall have an area-weighted average *U*-factor of the wall assembly not exceeding 0.102.
4. Light mass walls—A 6 inch or greater hollow core concrete masonry unit shall have a *U*-factor not to exceed 0.440.
5. Heavy mass walls—An 8 inch or greater hollow core concrete masonry unit shall have a *U*-factor not to exceed 0.690.
6. Spandrel panels and curtain wall—The area-weighted average *U*-factor of the spandrel panels and curtain wall assembly shall not exceed 0.280.
7. Demising walls—The opaque portions of framed demising walls shall meet the requirements of Item A or B below:
   A. Wood framed walls shall be insulated to meet a *U*-factor not greater than 0.099.
   B. Metal framed walls shall be insulated to meet a *U*-factor not greater than 0.151.
8. Bay or bow window roofs and floors shall be insulated to meet the wall insulation requirements of Table 170.2-A.

(c) **Floor and soffit insulation.** The opaque portions of floors and soffits that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:

1. Raised mass floors shall have a minimum of 3 inches of lightweight concrete over a metal deck or the area-weighted average *U*-factor of the floor assembly shall not exceed 0.269.

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2. Raised wood floor shall have an overall assembly *U*-factor not exceeding 0.037. In a wood framed assembly, compliance with the *U*-factor may be demonstrated by installing insulation with an *R*-value of 19 or greater.
3. Other floors—The area-weighted average *U*-factor of the floor assembly shall not exceed 0.071.
4. Heated slab on grade floor—A heated slab on grade floor shall be insulated to meet the requirements of Section 110.8(g).

Exception to Section 160.1(c): A building with a controlled ventilation or unvented crawl space may omit raised floor insulation if all of the following are met:

A. The foundation walls are insulated to meet the wall insulation minimums as shown in Table 170.2-A; and
B. A Class I or Class II vapor retarder is placed over the entire floor of the crawl space; and
C. Vents between the crawl space and outside air are fitted with automatically operated louvers that are temperature actuated; and
D. The requirements in Reference Residential Appendix RA4.5.1.

(d) **Vapor retarder.**

1. In Climate Zones 1–16, the earth floor of unvented crawl space shall be covered with a Class I or Class II vapor retarder. This requirement shall also apply to controlled ventilation crawl space for buildings complying with the Exception to Section 160.1(c).
2. In Climate Zones 14 and 16, a Class I or Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.

(e) **Fenestration products.** Fenestration separating conditioned space from unconditioned space or outdoors shall meet the requirements of either Item 1 or 2 below:

1. Fenestration, including skylight products, must have a maximum *U*-factor of 0.58.

Exception 1 to Section 160.1(e)1: Up to 0.5 percent of the conditioned floor area is not required to comply with the maximum *U*-factor requirement.

Exception 2 to Section 160.1(e)1: For dual-glazed greenhouse or garden windows, up to 30 square feet of fenestration area per dwelling unit is not required to comply with the maximum *U*-factor requirement.

2. The area-weighted average *U*-factor of all fenestration, including skylight products, shall not exceed 0.58.

Exception to Section 160.1(e): Fenestration installed in buildings meeting Part 7 of the *California Building Code, California Wildland-Urban Interface Code*, where the building is located in Fire Hazard Severity Zones or Wildland-Urban Interface (WUI) Fire Areas as designated by the local enforcement agency.

(f) **Installation of fireplaces, decorative gas appliances and gas logs.** If a masonry or factory-built fireplace is installed, it shall comply with Section 110.5, Section 4.503 of Part 11, and shall have the following:

1. Closable metal or glass doors covering the entire opening of the firebox; and
2. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable and tight-fitting damper or combustion-air control device; and

Exception to Section 160.1(f)2: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

3. A flue damper with a readily accessible control.

Exception to Section 160.1(f)3: When a gas log, log lighter or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.

(g) **Slab edge insulation.** Slab edge insulation shall meet the following minimum specifications:

1. Insulation material alone without the facing shall have a water absorption rate no greater than 0.3 percent when tested in accordance with ASTM C272, Test Method A – 24-Hour-Immersion; and
2. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM C272; and
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration; and
4. Insulation for a heated slab floor shall meet the requirements of Section 110.8(g).

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.2—MANDATORY REQUIREMENTS FOR VENTILATION AND INDOOR AIR QUALITY

(a) **General requirements.**

1. Attached dwelling units in multifamily buildings shall comply with the applicable requirements of Subsection 160.2(b) below. Occupiable spaces in multifamily buildings other than attached dwelling units shall comply with the applicable requirements of Section 160.2(c). When field verification and diagnostic testing of attached dwelling units is required by Section 160.2, buildings with three habitable stories or fewer shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

NOTE: Section 160.2 is not applicable to townhouses or dwellings that contain two dwelling units.

2. The required outdoor air-ventilation rate and the air-distribution system design shall be clearly identified on the building design plans submitted to the enforcement agency in accordance with Section 10-103 of Title 24, Part 1.

(b) **Attached dwelling units.** Attached dwelling units shall comply with the requirements of Subsections 1 and 2 below.

1. **Air filtration.**

A. System types specified in Subsections i, ii and iii shall be provided with air filters in accordance with Sections 160.2(b)1B, 160.2(b)1C and 160.2(b)1D. System types specified in Subsection i shall also comply with Section 160.2(b)1E.

i. Mechanical space-conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems, and energy recovery ventilation systems that provide outside air to an occupiable space.

B. **System design and installation.**

i. The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space are filtered before passing through any system's thermal conditioning components.

Exception to Section 160.2(b)1Bi: For heat recovery ventilators and energy recovery ventilators, the location of the filters required by Section 160.2(b)1 may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

ii. All systems shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter(s). The design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter, shall be determined and reported on labels according to Subsection iv below.

Systems specified in Section 160.2(b)1Ai shall be equipped with air filters that meet either Subsection a or b below:

a. Nominal 2-inch minimum depth filter(s) shall be sized by the system designer, or

b. Nominal 1-inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 160.2-A, based on a maximum face velocity of 150 ft per minute and according to the maximum allowable clean-filter pressure drop specified in Section 160.2(b)1Dii.

(Equation 160.2-A) $A_{face} = Q_{filter} / V_{face}$

where:

A_{face} = air filter face area, the product of air filter nominal length × nominal width, ft^2.

Q_{filter} = design airflow rate for the air filter, ft^3/min

V_{face} = air filter face velocity ≤ 150 ft/min

iii. All system air filters shall be located and installed in such a manner as to be accessible for regular service by the system owner.

iv. All system air filter installation locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop. The labels shall be permanently affixed to the air filter installation location, readily legible and visible to a person replacing the air filter.

v. Filter racks or grilles shall use gaskets, sealing or other means to close gaps around inserted filters and prevent air from bypassing the filter.

C. **Air filter efficiency.** The system shall be provided with air filters having a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30–1.0 µm range, and equal to or greater than 85 percent in the 1.0–3.0 µm range when tested in accordance with AHRI Standard 680.

D. **Air filter pressure drop.** All systems shall be provided with air filters that conform to the applicable maximum allowable clean-filter pressure drop specified in Subsection i, ii, iii or iv below, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rates for the system air filters.

i. The maximum allowable clean-filter pressure drop shall be determined by the system design for the nominal 2-inch minimum depth air filter required by Section 160.2(b)1Biia, or

ii. A maximum of 25 Pa (0.1 inches water) clean-filter pressure drop shall be allowed for a nominal 1-inch depth air filter sized according to Section 160.2(b)1Biib, or

iii. For systems specified in Sections 160.2(b)1Aii and 160.2(b)1Aiii, the maximum allowable clean filter pressure drop shall be determined by the system design.

iv. If Exception 1 to Section 160.3(b)5Lii or iv is utilized for compliance with cooling system airflow rate and fan efficacy requirements, the clean-filter pressure drop for the system air filter shall conform to the requirements given in Table 160.3-A or 160.3-B.

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E. **Air filter product labeling.** Systems described in Section 160.2(b)1Ai shall be equipped with air filters that have been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 160.2(b)1C and 160.2(b)1D.

Exception to Section 160.2(b)1: Evaporative coolers are not required to comply with the air filtration requirements in Section 160.2(b)1.

2. **Ventilation and indoor air quality for attached dwelling units**. All attached dwelling units shall meet the requirements of ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Residential Buildings subject to the amendments specified in Section 160.2(b)2A below. All dwelling units shall comply with Section 160.2(b)2B below.

Exception to Section 160.2(b)2 The following sections of ASHRAE 62.2 shall not be required for compliance: Section 4.1.1, Section 4.1.2, Section 4.1.4, Section 4.2, Section 4.3, Section 4.6, Section 5, Section 6.1.1, Section 6.1.3 and Normative Appendix A.

A. Amendments to ASHRAE 62.2 requirements.

i. **Window operation**. Window operation is not a permissible method of providing the dwelling unit ventilation airflow specified in Subsection iv or v below.

ii. **Central fan integrated (CFI) ventilation systems**.

a. Continuous operation prohibition. Continuous operation of a dwelling unit's central forced air system air handlers used in CFI ventilation systems is not a permissible method of providing the whole-dwelling unit ventilation airflow required by Section 160.2(b)2Aiv.

Exception to Section 160.2(b)2Aiia: The Energy Commission may approve continuous operation of central fan integrated ventilation systems pursuant to Section 10-109(h).

b. Outdoor air damper(s). A motorized damper(s) shall be installed on the connected ventilation duct(s) of CFI systems that prevents all airflow into or out of the space-conditioning duct system when the damper(s) is closed.

c. Damper control. The required motorized damper(s) shall be controlled to be in an opened position when outdoor air ventilation is required for compliance, and shall be in the closed position when ventilation air is not required. The damper(s) shall be closed whenever the space-conditioning system air handling unit is not operating. If the outdoor airflow for the CFI ventilation system is fan-powered, then the outdoor air fan shall not operate when the required motorized damper(s) on the outdoor air ventilation duct(s) is closed.

d. Variable ventilation. CFI ventilation systems shall incorporate controls that track outdoor air ventilation run time, and either open or close the required motorized damper(s) depending on whether or not outdoor air ventilation is required for compliance with Section 160.2(b)2Aiv. During periods when comfort conditioning is not called for by the space-conditioning thermostat, the CFI ventilation system controls shall operate the space-conditioning system central fan and outdoor air damper(s) when necessary to ensure compliance with the minimum outdoor air ventilation required by Section 160.2(b)2Aiv in accordance with applicable variable mechanical ventilation methods specified in ASHRAE 62.2 Section 4.5.

iii. **Air filtration.** Air filtration shall conform to the specifications in Section 160.2(b)1. Compliance with ASHRAE 62.2 Sections 6.7 (Minimum Filtration) and 6.7.1 (Filter Pressure Drop) shall not be required.

iv. **Whole-dwelling unit mechanical ventilation**. Multifamily attached dwelling units shall comply with Subsections a and b below.

a. Mechanical ventilation airflow shall be provided at rates greater than or equal to the value determined in accordance with Equation 160.2-B.

Total Required Ventilation Rate [ASHRAE 62.2:4.1.1]:

(Equation 160.2-B) $Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$

where:

Q_{tot} = total required ventilation rate, cfm.

A_{floor} = dwelling-unit floor area, ft^2.

N_{br} = number of bedrooms (not to be less than 1).

b. All dwelling units in a multifamily building shall use the same whole-dwelling unit ventilation system type. The dwelling unit shall comply with Subsections 1 and 2 below.

1. **Balanced or supply ventilation**. A balanced or supply ventilation system shall provide the required whole-dwelling-unit ventilation airflow. Balanced systems with heat recovery or energy recovery that serve a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm; and

2. **Compartmentalization testing.** The air leakage rate shall not exceed 0.3 cubic feet per minute at 50 Pa (0.2 inch water) per ft^2 of dwelling unit envelope surface area as confirmed by ECC-Rater field verification and diagnostic testing in accordance with the procedures specified in Reference Appendix RA3.8 or NA2.3 as applicable. In multifamily buildings with four or more habitable stories,

the field verification and diagnostic testing which requires an ECC-Rater may alternatively be performed by a certified Mechanical Acceptance Test Technician according to the requirements specified in Reference Appendix NA1.9.

v. **Multifamily building central ventilation system airflow rate tolerance.** Multifamily building central ventilation systems that serve multiple dwelling units shall have airflow rates in each dwelling unit served that meet or exceed a design ventilation airflow rate specification.

a. Designers shall specify a design ventilation airflow rate for each dwelling unit that is equal to or greater than the rate specified by Equation 160.2-B.

b. The design ventilation airflow rate for each dwelling unit shall be stated on the building design plans approved by the enforcement agency.

c. Airflow in each dwelling unit shall be no more than 20 percent greater than the specified design ventilation airflow rate. Ventilation systems shall utilize mechanical or software airflow control means to ensure each of the dwelling-unit airflows can be maintained at the design ventilation airflow within this tolerance at all times. System airflow control-means may include but are not limited to constant air regulation devices, orifice plates and variable speed central fans.

vi. **Local mechanical exhaust.** A local mechanical exhaust system shall be installed in each kitchen and bathroom. Systems shall be rated for airflow in accordance with ASHRAE 62.2 Section 7.1.

a. **Nonenclosed kitchens** shall have a demand-controlled mechanical exhaust system meeting the requirements of Section 160.2(b)2Avic.

b. **Enclosed kitchens and all bathrooms** shall have either one of the following options 1 or 2:

1. A demand-controlled mechanical exhaust system meeting the requirements of Section 160.2(b)2Avic; or
2. A continuous mechanical exhaust system meeting the requirements of Section 160.2(b)2Avid.

c. **Demand-controlled mechanical exhaust.** A local mechanical exhaust system shall be designed to be operated as needed.

1. **Control and operation.** Demand-controlled mechanical exhaust systems shall be provided with at least one of the following controls:
   A. A readily accessible occupant-controlled ON-OFF control.
   B. An automatic control that does not impede occupant ON control.
2. **Ventilation rate and capture efficiency.** The system shall meet or exceed either the minimum airflow in accordance with Table 160.2-E or the minimum capture efficiency in accordance with Table 160.2-E, and Table 160.2-G. Capture efficiency ratings shall be determined in accordance with ASTM E3087, and listed in a product directory approved by the Energy Commission.

d. **Continuous mechanical exhaust.** A mechanical exhaust system shall be installed to operate continuously. The system may be part of a balanced mechanical ventilation system.

1. **Control and operation**. A manual ON-OFF control shall be provided for each continuous mechanical exhaust system. The system shall be designed to operate during all occupiable hours. For multifamily dwelling units, the manual ON-OFF control may be accessible to the dwelling unit occupant; however, the manual ON-OFF control shall not be required to be accessible to the dwelling unit occupant.
2. **Ventilation rate.** The minimum delivered ventilation shall be at least the amount indicated in Table 160.2-F during each hour of operation.

e. **Airflow measurement of local mechanical exhaust by the system installer.** The airflow required by Section 160.2(b)2Avi is the quantity of indoor air exhausted by the ventilation system as installed in the dwelling unit. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with Section 160.2(b)2Avic2, the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be met by the installed system. The as-installed airflow shall be verified by the system installer to ensure compliance by use of either Subsection 1 or 2 below:

1. The system installer shall measure the airflow by using a flow hood, flow grid or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Appendix RA3.7 or NA2.2 as applicable.
2. As an alternative to performing an airflow measurement of the system as installed in the dwelling unit, compliance may be demonstrated by installing an exhaust fan and duct system that conforms to the specifications of Table 160.2-H. Visual inspection shall verify the installed system conforms to the requirements of Table 160.2-H.

   When using Table 160.2-H for demonstrating compliance, the airflow rating shall be greater than or equal to the value required by Section 160.2(b)2Avi at a static pressure greater than or equal to 0.25 in. of water (62.5 Pa). When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with Section 160.2(b)2Avic2, a static pressure greater than or equal to 0.25 in. of water

at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 160.2-H for determining compliance.

Use of Table 160.2-H is limited to ventilation systems that conform to all of the following three specifications:

A. Total duct length is less than or equal to 25 feet (8 m),

B. Duct system has no more than three elbows, and

C. Duct system has exterior termination fitting with a hydraulic diameter greater than or equal to the minimum duct diameter and not less than the hydraulic diameter of the fan outlet.

f. **Sound ratings for local mechanical exhaust**. Local mechanical exhaust systems shall be rated for sound in accordance with Section 7.3 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 160.2(b)2Avi.

Exception to Section 160.2(b)2Avif: Kitchen range hoods may be rated for sound at a static pressure determined at working speed as specified in HVI 916 Section 7.2.

vii. **Airflow measurement of whole-dwelling unit ventilation**. The airflow required by Section 160.2(b)2Aiv or 160.2(b)2Av is the quantity of outdoor ventilation air supplied or indoor air exhausted by the mechanical ventilation system as installed and shall be measured by using a flow hood, flow grid or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Appendix Section RA3.7.4.1.1 or NA2.2.4.1.1 as applicable for supply and exhaust systems or RA3.7.4.1.2 or NA2.2.4.1.2 as applicable for balanced systems. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows.

viii. **Sound ratings for whole-dwelling unit ventilation systems.** Whole-dwelling unit ventilation systems shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 160.2(b)2Aiv or 160.2(b)2Av as applicable.

ix. **Label for whole-dwelling unit ventilation system on-off control**. Compliance with ASHRAE 62.2 Section 4.4 (Control and Operation) shall require manual ON-OFF control switches associated with whole-dwelling unit ventilation systems to have a label clearly displaying the following text, or equivalent text: "This switch controls the indoor air quality ventilation for the home. Leave switch in the 'on' position at all times unless the outdoor air quality is very poor."

x. **Combustion air and compensating outdoor air or makeup air.**

a. All dwelling units shall conform to the applicable requirements specified in *California Mechanical Code* Chapter 7, Combustion Air.

b. All dwelling units shall conform to the requirements in ASHRAE 62.2 Section 6.4, Combustion and Solid-Fuel-Burning Appliances.

xi. **Balanced and supply ventilation component accessibility.** Balanced and supply ventilation systems shall meet the following requirements for accessibility:

a. **IAQ filter and HRV/ERV accessibility.** System air filters and HRV/ERV heat/energy recovery cores shall be located such that they are accessible for service from within occupiable spaces, basements, garages, balconies, mechanical closets or accessible rooftops. Filters and heat/energy recovery cores behind access panels, access doors, or grilles located no more than 10 feet above a walking surface inside a space specified above comply with this requirement.

Exception to Section 160.2(b)2Axia: Systems that require servicing from inside the attic shall have the following:

1. A fault indicator display (FID) meeting the requirements of Reference Appendix JA 17; and
2. An attic access door located in a wall or, where attic access is provided through a ceiling, an attic access hatch that includes an integrated ladder; and
3. A walkway from the attic access door to the HRV/ERV.

b. **IAQ system component accessibility.** Fans, motors, heat exchangers, filters and recovery cores shall meet all applicable requirements of *California Mechanical Code* Section 304.0 accessibility of service.

> B. **Dwelling unit field verification and diagnostic testing.**

i. **Whole-dwelling unit ventilation airflow performance**. The whole-dwelling unit ventilation airflow required by Section 160.2(b)2Aiv or 160.2(b)2Av shall be confirmed through field verification and diagnostic testing in accordance with Reference Appendix RA3.7.4.1.1 or NA2.2.4.1.1 as applicable for supply and exhaust systems or RA3.7.4.1.2 or NA2.2.4.1.2 as applicable for balanced systems. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to comply with the required ventilation airflows.

ii. **Kitchen local mechanical exhaust—vented range hoods.** Vented range hoods installed to comply with local mechanical exhaust requirements specified in Section 160.2(b)2Avi shall be field verified in accordance with

Reference Appendix RA3.7.4.3 or NA2.2.4.1.4 as applicable to confirm the model is rated by HVI or AHAM to comply with the following requirements:

a. The minimum ventilation airflow rate as specified by Section 160.2(b)2Avi, or alternatively the minimum capture efficiency as specified by Section 160.2(b)2Avi; and

b. The maximum sound rating as specified in Section 160.2(b)2Avif.

iii. **Heat recovery ventilation (HRV) and energy recovery ventilation (ERV) system fan efficacy.** At a minimum, systems with heat or energy recovery serving a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm as confirmed by field verification in accordance with Reference Appendix RA3.7.4.4 or NA2.2.4.1.5 as applicable. If Section 170.2(c)3Biva requirements are applicable to the dwelling unit, then field verification shall instead confirm compliance with the maximum fan efficacy and minimum sensible recovery efficiency specified in Section 170.2(c)3Biva in accordance with the procedures specified in Reference Appendix RA3.7.4.4 or NA2.2.4.1.5 as applicable.

iv. In multifamily buildings with four or more habitable stories, the field verification and diagnostic testing required in Sections 160.2(b)2Bi, ii and iii which requires an ECC-Rater may alternatively be performed by a certified Mechanical Acceptance Test Technician according to the requirements specified in Reference Appendix NA1.9.

C. **Multifamily building central ventilation system field verification.**

i. **Central ventilation system duct sealing.** Ventilation ducts that conform to Subsections a and b below shall meet the duct sealing requirements in *California Mechanical Code* Section 603.10 and have leakage that is no greater than 6 percent of the rooftop fan or central fan design airflow rate as confirmed by field verification in accordance with the procedures in Reference Appendix NA7.18.3. The leakage test shall be conducted using a test pressure of 25 Pa (0.1 inches) for ducts serving six or fewer dwelling units and 50 Pa (0.2 inches) for ducts serving more than six dwelling units, and shall measure the leakage of all ductwork between the central fan and the connection point to the in-unit grille or fan.

a. The ventilation ducts serve multiple dwelling units.

b. The ventilation ducts provide continuous airflows or airflows to provide balanced ventilation to meet the requirements specified in Section 160.2(b)2Aiv or 160.2(b)2Av as applicable.

Exception to Section 160.2(b)2C: Multifamily buildings with three or fewer habitable stories in Climate Zone 6 are not required to comply with Section 160.2(b)2C.

(c) **Common use areas.** All occupiable spaces shall comply with the requirements of Subsection 1 and shall also comply with either Subsection 2 or Subsection 3:

1. **Air filtration.**

A. Mechanical system types specified in Subsections i, ii and iii below shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space are filtered before passing through any system's thermal conditioning components. Air filters shall conform to the requirements of Sections 160.2(c)1B, 160.2(c)1C and 160.2(c)1D.

i. Mechanical space-conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems and energy recovery ventilation systems that provide outside air to an occupiable space.

Exception to Section 160.2(c)1A: For heat recovery ventilators and energy recovery ventilators, the location of the filters required by Section 160.2(c)1A may be downstream of a system's thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

B. **Air filter efficiency**. The filters shall have a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30–1.0 µm range, and equal to or greater than 85 percent in the 1.0–3.0 µm range when tested in accordance with AHRI Standard 680; and

C. Systems shall be equipped with air filters that meet either Subsection i or ii below.

i. Nominal 2 inch minimum depth filter(s); or

ii. Nominal 1 inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 160.2-A, based on a maximum face velocity of 150 ft per minute.

D. Filter racks or grilles shall be gasketed or sealed to eliminate any gaps around the filter to prevent air from bypassing the filter.

2. **Natural ventilation.** Naturally ventilated spaces shall be designed in accordance with Sections 160.2(c)2A through 160.2(c)2D.

A. **Floor area to be ventilated**. Spaces or portions of spaces to be naturally ventilated shall be located within a distance based on the ceiling height, as specified in i, ii and iii. The ceiling height (H) to be used in i, ii or iii shall be the minimum ceiling height in the space, or for ceilings that are increasing in height as distance from the operable openings is

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increased, the ceiling height shall be determined as the average height of the ceiling within 20 ft from the operable opening. [ASHRAE 62.1:6.4.1.1]

i. Single side opening. For spaces with operable opening on one side of the zone, the naturally ventilated area shall extend to a distance not greater than two times the height (H) of the ceiling from the openings. [ASHRAE 62.1:6.4.1.3]

ii. Double side opening. For zones with openings on two opposite sides of the zone, the naturally ventilated area shall extend between the openings separated by a distance not greater than five times the height of the ceiling. [ASHRAE 62.1:6.4.1.4]

iii. Corner opening. For zones with operable openings on two adjacent sides of a zone, the naturally ventilated area shall extend to a distance not greater than five times the height of the ceiling along a line drawn between the outside edges of the two openings that are the farthest apart. Floor area outside that line shall comply with i as having openings on only one side of the zone. [ASHRAE 62.1:6.4.1.5]

Note: "Floor area outside that line" refers to the remaining area of the zone that is not bounded by the walls that have the openings and the line drawn between the openings.

iv. Ceiling height. The ceiling height (H) to be used in Sections 160.2(c)2Ai through 160.2(c)2Aiii shall be the minimum ceiling height in the space.

Exception to Section 160.2(c)2Aiv: For ceilings that are increasing in height as distance from the opening is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet from the operable openings. [ASHRAE 62.1:6.4.1.1]

B. **Location and size of openings.** Zones or portions of zones to be naturally ventilated shall have a permanently open airflow path to openings directly connected to the outdoors. The openable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, the openable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet. [ASHRAE 62.1:6.4.1.6]

C. **Control and accessibility.** The means to open the required operable opening shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

D. Naturally ventilated spaces shall also include a mechanical ventilation system designed in accordance with Section 160.2(c)3.

Exception 1 to Section 160.2(c)2D: Spaces not served by a space-conditioning system.

Exception 2 to Section 160.2(c)2D: Spaces where natural ventilation openings complying with Section 120.1(c)2 are either permanently open or have controls that prevent the openings from being closed during periods of expected occupancy.

3. **Mechanical ventilation.** Occupiable spaces shall be ventilated with a mechanical ventilation system capable of providing an outdoor airflow rate (V_z) to the zone no less than the Equation 160.2-H as described below:

(Equation 160.2-H) V_z = The larger of $R_p \times P_z$ or $R_a \times A_z$

where:

R_p = 15 cubic feet per minute of outdoor airflow per person.

P_z = The expected number of occupants. For spaces without fixed seating, the expected number of occupants shall be the expected number specified by the building designer or the default occupancy density in Table 160.2-B times the occupiable floor area of the zone, whichever is greater. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with the *California Building Code* Section 1004.6.

R_a = The area-based minimum ventilation airflow rate in Table 160.2-B.

A_z = The net occupiable floor area of the ventilation zone in square feet.

Exception to Section 160.2(c)3: Transfer air. The rate of outdoor air required by Section 160.2(c)3 may be provided with air transferred from other ventilated space if:

i. Use of transfer air is in accordance with Section 160.2(c)8; and

ii. The outdoor air that is supplied to all spaces combined is sufficient to meet the requirements of Section 160.2(c)3 for each space individually.

4. **Exhaust ventilation.** The design exhaust airflow shall be determined in accordance with the requirements in Table 160.2-C. Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air or transfer air. [ASHRAE 62.1:6.5.1]

5. **Operation and control requirements for minimum quantities of outdoor air**.

A. **Times of occupancy.** The minimum rate of outdoor air required by Section 160.2(c) shall be supplied to each space at all times when the space is usually occupied.

Exception 1 to Section 160.2(c)5A: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gases and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service

preparation), the rate of outdoor air may be reduced if the ventilation system serving the space is controlled by a demand control ventilation device complying with Section 160.2(c)5D or by an occupant sensor ventilation control device complying with Section 160.2(c)5E.

Exception 2 to Section 160.2(c)5A: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 160.2(c) for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.

B. **Preoccupancy.** The lesser of the minimum rate of outdoor air required by Section 160.2(c) or three complete air changes shall be supplied to the entire building during the 1-hour period immediately before the building is normally occupied.

C. **Required demand control ventilation.** Demand ventilation controls complying with Section 160.2(c)5D are required for a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 square feet (40 square feet or less per person) if the system serving the space has one or more of the following:

i. An air economizer; or

ii. Modulating outside air control; or

iii. Design outdoor airflow rate > 3,000 cfm.

Exception 1 to Section 160.2(c)5C: Where space exhaust is greater than the design ventilation rate specified in Section 160.2(c)3 minus 0.2 cfm per ft^2 of conditioned area.

Exception 2 to Section 160.2(c)5C: Spaces that have processes or operations that generate dusts, fumes, mists, vapors or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, daycare sickrooms, science labs, barber shops or beauty and nail salons, shall not install demand control ventilation.

Exception 3 to Section 160.2(c)5C: Spaces with an area of less than 150 square feet or a design occupancy of less than 10 people as specified by Section 160.2(c)3.

D. **Demand control ventilation devices.**

i. For each system with demand control ventilation (DCV), CO_2 sensors shall be installed in each room that meets the criteria of Section 160.2(c)5C with no fewer than one sensor per 10,000 ft^2 of floor space. When a zone or a space is served by more than one sensor, a signal from any sensor indicating that CO_2 is near or at the setpoint within the zone or space shall trigger an increase in ventilation.

ii. CO_2 sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants' heads.

iii. Demand ventilation controls shall maintain CO_2 concentrations less than or equal to 600 ppm plus the outdoor air CO_2 concentration in all rooms with CO_2 sensors.

Exception to Section 160.2(c)5Diii: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 160.2(c)3 regardless of CO_2 concentration.

iv. Outdoor air CO_2 concentration shall be determined by one of the following:

a. CO_2 concentration shall be assumed to be 400 ppm without any direct measurement; or

b. CO_2 concentration shall be dynamically measured using a CO_2 sensor located within 4 ft of the outdoor air intake.

v. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than $R_a \times A_z$ per Equation 160.2-H for each space with a CO_2 sensor(s), plus the greater of either the exhaust air rate or the rate required by Section 160.2(c)3 for other spaces served by the system.

vi. CO_2 sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal that resets to supply the minimum quantity of outside air to levels required by Section 160.2(c)3 to the zone serviced by the sensor at all times that the zone is occupied.

vii. The CO_2 sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with digital direct controls (DDC) to the zone level.

E. **Occupied-standby zone controls.**

i. Space-conditioning zones shall include occupied-standby controls complying with Table 160.2-B when all of the following are true:

a. All rooms served by the zone are permitted to have their ventilation air reduced to zero while in occupied-standby mode per Table 160.2-B; and

b. Occupant sensors are required by Sections 160.5(b)4Cv and vi; and

c. The zone and ventilation system are not served by pneumatic controls.

ii. Occupied-standby zone controls shall comply with the following:

a. Occupant sensors shall have suitable coverage and placement to detect occupants in the entire space. In 20 minutes or less after no occupancy is detected by any sensors covering the room, occupant sensing controls shall indicate a room is vacant.

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b. When occupant sensors controlling lighting are also used for ventilation, the ventilation signal shall be independent of daylighting, manual lighting overrides or manual control of lighting.

c. When a single zone damper or a single zone system serves multiple spaces, there shall be an occupant sensor in each space and the zone shall not be considered vacant until all spaces in the zone are vacant.

d. One hour prior to normal scheduled occupancy, the occupant sensor ventilation control shall allow preoccupancy purge as described in Section 160.2(c)5B.

e. When the zone is scheduled to be occupied and occupant sensing controls in all spaces served by the zone indicate the spaces are unoccupied, the zone shall be placed in occupied-standby mode.

f. In 5 minutes or less after entering occupied-standby mode, mechanical ventilation to the zone shall be shut off until the space becomes occupied or until ventilation is needed to provide space heating or conditioning. When mechanical ventilation is shut off to the zone, the ventilation system serving the zone shall reduce the system outside air rate by the amount of outside air required for the zone.

g. Where the system providing space conditioning also provides ventilation to the zone, in 5 minutes or less after entering occupied-standby mode, space-conditioning zone setpoints shall be reset in accordance with Section 120.2(e)3.

6. Ducting for zonal heating and cooling units. Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit that then supplies the air to a space in order to meet the requirements of Section 160.2(c)3, the outdoor air shall be ducted to discharge either:

A. Within 5 feet of the unit; or

B. Within 15 feet of the unit, substantially toward the unit and at a velocity not less than 500 feet per minute.

7. Design and control requirements for quantities of outdoor air.

A. All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers and controls to allow outside air rates to be operated at the minimum levels specified in Section 160.2(c)3 or the rate required for make-up of exhaust systems that are required for an exempt or covered process, for control of odors or for the removal of contaminants within the space.

B. All variable air volume mechanical ventilation and space-conditioning systems shall include dynamic controls that maintain measured outside air ventilation rates within 10 percent of the required outside air ventilation rate at both full and reduced supply airflow conditions. Fixed minimum damper position is not considered to be dynamic and is not an allowed control strategy.

C. Measured outdoor air rates of constant volume mechanical ventilation and space-conditioning systems shall be within 10 percent of the required outside air rate.

8. Air classification and recirculation limitations. Air classification and recirculation limitations of air shall be based on the air classification as listed in Table 160.2-B or Table 160.2-D, in accordance with the following:

A. Class 1 air is air with low contaminant concentration, low sensory-irritation intensity or inoffensive odor. Recirculation or transfer of Class 1 air to any space shall be permitted; [ASHRAE 62.1:5.13.3.1]

B. Class 2 air is air with moderate contaminant concentration, mild sensory-irritation intensity or mildly offensive odor (Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes). Recirculation or transfer of Class 2 air shall be permitted in accordance with Sections 160.2(c)8Bi through 160.2(c)8Bv:

i. Recirculation of Class 2 air within the space of origin shall be permitted [ASHRAE 62.1:5.13.3.2.1].

ii. Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space [ASHRAE 62.1:5.13.3.2.2]; or

iii. Transfer of Class 2 air to toilet rooms [ASHRAE 62.1:5.13.3.2.3]; or

iv. Recirculation or transfer of Class 2 air to Class 4 spaces [ASHRAE 62.1:5.13.3.2.4].

v. Class 2 air shall not be recirculated or transferred to Class 1 spaces. [ASHRAE 62.1:5.13.3.2.5].

Exception to Section 160.2(c)8Bv: When using any energy recovery device, recirculation from leakage, carryover or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 2 air shall not exceed 10 percent of the outdoor air intake flow.

C. Class 3 air is air with significant contaminant concentration, significant sensory-irritation intensity or offensive odor. Recirculation or transfer of Class 3 air shall be permitted in accordance with Sections 160.2(c)8Ci and 160.2(c)8Cii:

i. Recirculation of Class 3 air within the space of origin shall be permitted. [ASHRAE 62.1:5.13.3.3.1]

ii. Class 3 air shall not be recirculated or transferred to any other space. [ASHRAE 62.1:5.13.3.3.2].

Exception to Section 160.2(c)8Cii: When using any energy recovery device, recirculation from leakage, carryover or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 3 air shall not exceed 5 percent of the outdoor air intake flow.

D. Class 4 air is air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols or gases at concentrations high enough to be considered as harmful. Class 4 air shall not be recirculated or transferred to any space or recirculated within the space of origin. [ASHRAE 62.1:5.13.3.4]

E. Ancillary spaces. Redesignation of Class 1 air to Class 2 air shall be permitted for Class 1 spaces that are ancillary to Class 2 spaces. [ASHRAE 62.1:5.13.2.3]

F. Transfer. A mixture of air that has been transferred through or returned from spaces or locations with different air classes shall be redesignated with the highest classification among the air classes mixed. [ASHRAE 62.1:5.13.2.2]

G. Classification. Air leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Table 160.2-B, 160.2-C or 160.2-D. Air leaving spaces or locations that are not listed in Table 160.2-B, 160.2-C or 160.2-D shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

(d) **Parking garages.** Mechanical ventilation systems for enclosed parking garages in multifamily buildings shall comply with Section 120.6(c).

Table 160.2-A: Reserved.

TABLE 160.2-B—MINIMUM OCCUPANT LOAD DENSITY AND VENTILATION RATES FOR MULTIFAMILY COMMON USE AREAS

SPACE TYPE	MINIMUM OCCUPANT LOAD DENSITY (p/1000 ft^2)[1]	AREA-BASED MINIMUM VENTILATION R_a (cfm/ft^2)	AIR CLASS	NOTES
Bars, cocktail lounges	33	0.2	2	—
Break rooms	33	0.15	1	F
Coffee stations	33	0.15	1	F
Conference/meeting	33	0.15	1	F
Corridors	5	0.15	1	F
Computer (not printing)	5	0.15	1	F
Daycare (through age 4)	14	0.15	2	—
Dining rooms	33	0.15	2	—
Disco/dance floors	100	0.15	2	F
Freezer and refrigerated spaces (< 50°F)	0	0	2	E
Game arcades	45	0.15	1	—
Gym, sports arena (play area)	10	0.15	2	E
Health club/aerobics room/weight rooms	10	0.15	2	—
Kitchen (cooking)	3	0.15	2	—
Laundry rooms, central	5	0.15	2	—
Lobbies/prefunction	33	0.15	1	F
Multiuse assembly	33	0.15	1	F
Occupiable storage rooms for dry materials	2	0.15	1	—
Occupiable storage rooms for liquids or gels	2	0.15	2	B
Office space	5	0.15	1	F
Reception areas	5	0.15	1	F
Shipping/receiving	2	0.15	2	B
Spectator areas	33	0.15	1	F
Swimming (deck)	33	0.15	2	C
Swimming (pool)	10	0.15	2	C
Telephone/data entry	33	0.15	1	F
All others	5	0.15	2	—

General:

1. The minimum occupant density is one-half of the maximum occupant load assumed for egress purposes in the CBC.
2. If this column specifies a minimum cfm/ft^2, then it shall be used to comply with Section 160.2(c)5E.
3. For spaces not included in this table, the spaces in Table 120.1-A shall apply.

Specific Notes:

A – RESERVED.

B – Rate may not be sufficient where stored materials include those having potentially harmful emissions.

C – Rate does not allow for humidity control. "Deck area" refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.

D – RESERVED.

E – Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.

F – Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.

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TABLE 160.2-C—MINIMUM EXHAUST RATES
[ASHRAE 62.1: TABLE 6.2]

OCCUPANCY CATEGORY[1]	EXHAUST RATE, cfm/unit	EXHAUST RATE, cfm/ft^2	AIR CLASS	NOTES
Copy, printing rooms	—	0.50	2	—
Janitor closets, trash rooms, recycling	—	1.00	3	—
Kitchenettes	—	0.30	2	—
Kitchens – commercial	—	0.70	2	—
Locker rooms for athletic or industrial facilities	—	0.50	2	—
All other locker rooms	—	0.25	2	—
Shower rooms	20/50	—	2	G, H
Parking garages	—	0.75	2	C
Pet shops (animal areas)	—	0.90	2	—
Soiled laundry storage rooms	—	1.00	3	F
Storage rooms, chemical	—	1.50	4	F
Toilets – private	25/50	—	2	E
Toilets – public	50/70	—	2	D

A – RESERVED.
B – RESERVED.
C – Exhaust shall not be required where two or more sides comprise walls that are at least 50 percent open to the outside.
D – Rate is per water closet, urinal or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.
E – Rate is for a toilet room intended to be occupied by one person at a time. For continuous systems operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
F – See other applicable standards for exhaust rate.
G – For continuous system operation, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
H – Rate is per showerhead.
Notes:
1. For spaces not included in this table, the spaces in Table 120.1-B shall apply.

TABLE 160.2-D—AIRSTREAMS OR SOURCES
[ASHRAE 62.1:TABLE 6-3]

DESCRIPTION	AIR CLASS
Commercial kitchen grease hoods	4
Commercial kitchen hoods other than grease	3
Hydraulic elevator machine room	2
Refrigerating machinery rooms	3

TABLE 160.2-E—DEMAND-CONTROLLED LOCAL VENTILATION EXHAUST AIRFLOW RATES AND CAPTURE EFFICIENCY

APPLICATION	COMPLIANCE CRITERIA
Enclosed kitchen or nonenclosed kitchen	Vented range hood, including appliance-range hood combinations shall meet either the capture efficiency (CE) or the airflow rate specified in Table 160.2-G, as applicable.
Enclosed kitchen or nonenclosed kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s).
Bathroom	50 cfm (25 L/s)

TABLE 160.2-F—CONTINUOUS LOCAL VENTILATION EXHAUST AIRFLOW RATES	
APPLICATION	**AIRFLOW**
Enclosed kitchen	5 ach, based on kitchen volume
Bathroom	20 cfm (10 L/s)

TABLE 160.2-G—KITCHEN RANGE HOOD AIRFLOW RATES (cfm) AND ASTM E3087 CAPTURE EFFICIENCY (CE) RATINGS ACCORDING TO DWELLING UNIT FLOOR AREA AND KITCHEN RANGE FUEL TYPE		
DWELLING UNIT FLOOR AREA (FT^2)	**HOOD OVER ELECTRIC RANGE**	**HOOD OVER NATURAL GAS RANGE**
> 1500	50% CE or 110 cfm	70% CE or 180 cfm
> 1000–1500	50% CE or 110 cfm	80% CE or 250 cfm
750–1000	55% CE or 130 cfm	85% CE or 280 cfm
< 750	65% CE or 160 cfm	85% CE or 280 cfm

TABLE 160.2-H—PRESCRIPTIVE VENTILATION SYSTEM DUCT SIZING [ASHRAE 62.2:TABLE 5-3]													
Fan airflow rating, cfm at minimum static pressure[f] 0.25 in. water (L/s at minimum 62.5 Pa)	≤50 (25)	≤80 (40)	≤100 (50)	≤125 (60)	≤150 (70)	≤175 (85)	≤200 (95)	≤250 (120)	≤350 (165)	≤400 (190)	≤450 (210)	≤700 (330)	≤800 (380)
Minimum duct diameter, in. (mm) [a,b] for rigid duct	4 [e] (100)	5 (125)	5 (125)	6 (150)	6 (150)	7 (180)	7 (180)	8 (205)	9 (230)	10 (255)	10 (255)	12 (305)	12 [d] (305)
Minimum duct diameter, in. (mm) [a,b] for flex duct [c]	4 (100)	5 (125)	6 (150)	6 (150)	7 (150)	7 (180)	8 (205)	8 (205)	9 (230)	10 (255)	NP	NP	NP

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.
b. NP = application of the prescriptive table is not permitted for this scenario.
c. Use of this table for verification of flex duct systems requires flex duct to be fully extended and any flex duct elbows to have a minimum bend radius to duct diameter ratio of 1.0.
d. For this scenario, use of elbows is not permitted.
e. For this scenario, 4 in. (100 mm) oval duct shall be permitted, provided the minor axis of the oval is greater than or equal to 3 in. (75 mm).
f. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with Section 160.2(b)2Avic2, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 160.2-H for determining compliance.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

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SECTION 160.3 —MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING SYSTEMS IN MULTIFAMILY BUILDINGS

Space-conditioning systems serving multifamily dwelling units and common use areas shall comply with the applicable requirements of Sections 160.3(a) through 160.3(c).

(a) **Controls.** Space-conditioning systems serving dwelling units and common use areas in multifamily buildings shall comply with applicable requirements of Section 160.3(a)1 or 160.3(a)2.

1. **Dwelling unit thermostats.** All heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat, as specified in Section 110.2(c).
2. **Common use area controls**. Heating or cooling systems serving common use areas of multifamily buildings shall comply with application requirements of Sections 160.3(a)2A through 160.3(a)2J.

   Exception to Section 160.3(a)2: Heating or cooling systems exclusively serving dwelling units and common use areas providing shared provisions for living, eating, cooking or sanitation to dwelling units that would otherwise lack these provisions may instead comply with Section 160.3(a)1.

   A. **Thermostatic controls for each zone.** The supply of heating and cooling energy to each space-conditioning zone shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 160.3(a)2B. An energy management control system (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

      Exception to Section 160.3(a)2A: An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

      i. All zones are also served by an interior cooling system; and
      ii. The perimeter system is designed solely to offset envelope heat losses or gains; and
      iii. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
      iv. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

   B. **Criteria for zonal thermostatic controls.** The individual thermostatic controls required by Section 160.3(a)2A shall meet the following requirements as applicable:

      i. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
      ii. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
      iii. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items i and ii and shall be capable of providing a temperature range or deadband of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

         Exception to Section 160.3(a)2Biii: Systems with thermostats that require manual changeover between heating and cooling modes.

      iv. Thermostatic controls for all single zone air conditioners and heat pumps shall comply with the requirements of Sections 110.2(c) and 110.12(a) and, if equipped with DDC to the zone level, with the automatic demand shed controls of Section 110.12(b).

         Exception to Section 160.3(a)2Biv: Package terminal air conditioners, package terminal heat pumps, room air conditioners and room air-conditioner heat pumps.

   C. **Heat pump controls.** All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 110.2(b).

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

   D. **Shut-off and reset controls for space-conditioning systems.** Each space-conditioning system shall be installed with controls that comply with the following:

      i. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:
         a. An automatic time switch control device complying with Section 110.9, with an accessible manual override that allows operation of the system for up to 4 hours; or
         b. An occupancy sensor; or
         c. A 4-hour timer that can be manually operated.
      ii. The control shall automatically restart and temporarily operate the system as required to maintain:
         a. A setback heating thermostat setpoint if the system provides mechanical heating; and

            Exception to Section 160.3(a)2Diia: Thermostat setback controls are not required in multifamily buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 170.2(c)1C is greater than 32°F.

         b. A setup cooling thermostat setpoint if the system provides mechanical cooling.

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Exception to Section 160.3(a)2Diib: Thermostat setup controls are not required in multifamily buildings in areas where the summer design dry-bulb 0.5-percent temperature determined in accordance with Section 170.2(c)1C is less than 100°F.

iii. **Occupant sensing zone controls**. Where the system providing space conditioning also provides the ventilation required by Section 160.2(c)3 and includes occupant sensor ventilation control as specified in Section 160.2(c)5E, the occupant sensing zone controls shall additionally comply with the following:

a. Occupant sensing zone controls shall comply with the occupant sensor ventilation control device requirements of Section 160.3(c)5E and allow preoccupancy ventilation requirements of Section 160.3(c)5B; and

b. In 5 minutes or less after entering occupied-standby mode as described in Section 160.2(c)5:

I. Automatically set up the operating cooling temperature setpoint by 2°F or more and set back the operating heating temperature setpoint by 2°F or more; or

II. For multiple zone systems with direct digital controls (DDC) to the zone level, set up the operating cooling temperature setpoint by 0.5°F or more and set back the operating heating temperature setpoint by 0.5°F or more.

c. In 5 minutes or less after entering occupied-standby mode, mechanical ventilation to the zone shall remain off whenever the space temperature is between the active heating and cooling setpoints.

Exception to Section 160.3(a)2Diii: Zones that are only ventilated by a natural ventilation system in accordance with Section 120.1(c)2.

Exception 1 to Sections 160.3(a)2Di, ii and iii: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

Exception 2 to Sections 160.3(a)2Di, ii and iii: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

E. **Dampers for air supply and exhaust equipment.** Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

Exception 1 to Section 160.3(a)2E: Equipment that serves an area that must operate continuously.

Exception 2 to Section 160.3(a)2E: Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

Exception 3 to Section 160.3(a)2E: At combustion air intakes and shaft vents.

Exception 4 to Section 160.3(a)2E: Where prohibited by other provisions of law.

F. **Isolation area devices**. Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed and controlled to serve isolation areas.

i. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.

ii. Each isolation area shall be provided with isolation devices, such as valves or dampers that allow the supply of heating or cooling to be reduced or shut off independently of other isolation areas.

iii. Each isolation area shall be controlled by a device meeting the requirements of Section 160.3(a)2Di.

Exception to Section 160.3(a)2F: Zones designed to be conditioned continuously.

G. **Automatic demand shed controls.** See Section 110.12 for requirements for automatic demand shed controls.

H. **Economizer fault detection and diagnostics (FDD).** All newly installed air handlers with a mechanical cooling capacity over 33,000 Btu/hr and an installed air economizer shall include a stand-alone or integrated fault detection and diagnostics (FDD) system in accordance with Subsections 160.3(a)2Hi through 160.3(a)2Hviii.

i. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air and, when required for differential economizer operation, a return air sensor; and

ii. Temperature sensors shall have an accuracy of ±2°F over the range of 40°F to 80°F; and

iii. The controller shall have the capability of displaying the value of each sensor; and

iv. The controller shall provide system status by indicating the following conditions:

a. Free cooling available;

b. Economizer enabled;

c. Compressor enabled;

d. Heating enabled, if the system is capable of heating; and

e. Mixed air low limit cycle active.

v. The unit controller shall allow manual initiation of each operating mode so that the operation of cooling systems, economizers, fans and heating systems can be independently tested and verified; and

vi. Faults shall be reported in one of the following ways:

a. Reported to an energy management control system regularly monitored by facility personnel.

b. Annunciated locally on one or more zone thermostats, or a device within 5 feet of zone thermostat(s), clearly visible, at eye level and meeting the following requirements:

I. On the thermostat, the device or an adjacent written sign, display instructions to contact appropriate building personnel or an HVAC technician; and

II. In buildings with multiple tenants, the annunciation shall either be within property management offices or in a common space accessible by the property or building manager.

c. Reported to a fault management application that automatically provides notification of the fault to remote HVAC service provider.

vii. The FDD system shall detect the following faults:

a. Air temperature sensor failure/fault;

b. Not economizing when it should;

c. Economizing when it should not;

d. Damper not modulating; and

e. Excess outdoor air.

viii. The FDD system shall be certified to the Energy Commission as meeting the requirements of Sections 160.3(a)2Hi through 160.3(a)2Hvii in accordance with Section 110.0 and JA6.3.

Exception to Section 160.3(a)2Hviii: FDD algorithms based in direct digital control systems are not required to be certified to the Energy Commission.

I. **Direct digital controls (DDC).** Direct digital controls to the zone shall be provided as specified by Table 160.3-C.

i. The provided DDC system shall meet the control logic requirements of Sections 160.3(a)2E and 160.3(a)2G, and be capable of the following:

ii. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;

iii. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;

iv. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;

v. Readily allow operator removal of zone(s) from the reset algorithm;

vi. For new buildings, trending and graphically displaying input and output points; and

vii. Resetting heating and cooling setpoints in all noncritical zones upon receipt of a signal from a centralized contact or software point as described in Section 160.3(a)2G.

J. **Optimum start/stop controls.** Space-conditioning systems with DDC to the zone level shall have optimum start/stop controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

Exception to Section 160.3(a)2J: Systems that must operate continuously.

(b) **Dwelling unit space-conditioning and air distribution systems.**

1. **Building cooling and heating loads.** Building heating and cooling loads shall be determined using a method based on any one of the following, using cooling and heating loads as two of the criteria for equipment sizing and selection:

A. The ASHRAE Handbook, Equipment Volume, Applications Volume and Fundamentals Volume; or

B. The SMACNA Residential Comfort System Installation Standards Manual; or

C. The ACCA Manual J.

Exception to Section 160.3(b)1: Block loads, the total load for all rooms combined that are served by the central equipment, may be used for the purpose of system sizing for additions.

NOTE: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC.

2. **Design conditions**. Design conditions shall be determined in accordance with the following:

A. For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling.

B. Outdoor design conditions shall be selected from one of the following:

i. Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X; or

ii. The ASHRAE Handbook Fundamentals Volume; or

iii. The ACCA Manual J.

C. The outdoor design temperatures for heating shall be no lower than the 99.0 percent Heating Dry Bulb or the Heating Winter Median of Extremes values.

D. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

3. **Outdoor condensing units**.
   A. **Clearances.** Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least 5 feet (1.5 meters) from the outlet of any dryer vent.
   B. **Liquid line drier.** Installed air conditioner and heat pump systems shall be equipped with liquid line filter driers if required, as specified by manufacturer's instructions.
4. **Central forced-air heating furnaces**.
   A. **Temperature rise**. Central forced-air heating furnace installations shall be configured to operate in conformance with the furnace manufacturer's maximum inlet-to-outlet temperature rise specifications.
5. **Air-distribution and ventilation system ducts, plenums and fans.**
   A. **CMC compliance.**
      i. All air-distribution system ducts and plenums, including, but not limited to, mechanical closets and air-handler boxes, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0 and 605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference.
      ii. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall be insulated in accordance with either Subsection a or b below:
         a. Ducts shall have a minimum installed level of R-6.0, or

         Exception to Section 160.3(b)5Aiia: Portions of the duct system located in conditioned space below the ceiling separating the occupiable space from the attic are not required to be insulated if all of the following conditions are met:

      i. The noninsulated portion of the duct system is located entirely inside the building's thermal envelope as confirmed by visual inspection.
      ii. At all locations where noninsulated portions of the duct system penetrate into unconditioned space, the penetration shall be draft stopped compliant with CFC Sections 703.1 and 704.1 and air-sealed to the construction materials that are penetrated, using materials compliant with CMC Section E502.4.2 to prevent air infiltration into the cavity. All connections in unconditioned space are insulated to a minimum of R-6.0 as confirmed by visual inspection.
         b. Ducts do not require insulation when the duct system is located entirely in conditioned space. For buildings with three or fewer habitable stories, duct systems located entirely in conditioned space shall be confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.
      iii. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened.
      iv. Openings shall be sealed with mastic, tape or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.
      v. Building cavities, support platforms for air handlers, and plenums designed or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

      Exception to Section 160.3(b)5A: Ducts and fans integral to a wood heater or fireplace.
   B. **Factory-fabricated duct systems**.
      i. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.
      ii. All pressure-sensitive tapes, heat-activated tapes and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.
      iii. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.
      iv. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.
   C. **Field-fabricated duct systems.**
      i. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.
      ii. Mastic sealants and mesh.
         a. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 181B, and be nontoxic and water resistant.
         b. Sealants for interior applications shall be tested in accordance with ASTM C731 and D2202, incorporated herein by reference.

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c. Sealants for exterior applications shall be tested in accordance with ASTM C731, C732 and D2202, incorporated herein by reference.

d. Sealants and meshes shall be rated for exterior use.

iii. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.

iv. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

v. Drawbands used with flexible duct.

a. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

b. Drawbands shall have a minimum tensile strength rating of 150 pounds.

c. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

vi. Aerosol-sealant closures.

a. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

b. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

D. **Duct insulation *R*-value ratings.** All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor retarder or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

E. **Duct insulation thickness.** The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

i. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used**.**

ii. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

iii. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

F. **Duct labeling.** Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor retarder or other duct components), based on the tests in Section 160.3(b)5D and the installed thickness determined by Section 160.3(b)5Eiii.

G. **Backdraft dampers.** All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.

H. **Gravity ventilation dampers.** All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.

I. **Protection of insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service (e.g., protected by aluminum, sheet metal, painted canvas or plastic cover).

Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

J. **Porous inner core flex duct.** Flexible ducts having porous inner cores shall have a nonporous layer or air barrier between the inner core and the outer vapor barrier.

K. **Duct system sealing and leakage testing.** When space-conditioning systems utilize forced air duct systems to supply conditioned air to an individual dwelling unit, the ducts shall be sealed, as confirmed through field verification and diagnostic testing, in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1. Air handler airflow for calculation of duct leakage rate compliance targets shall be determined according to methods specified in Reference Residential Appendix RA3.1.4.2.

For multifamily dwellings with the air-handling unit installed and the ducts connected directly to the air handler, regardless of duct system location:

i. The total leakage of the duct system shall not exceed 12 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

ii. The duct system leakage to outside shall not exceed 6 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

>| | **Exception 1 to Section 160.3(b)5K:** The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four

habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

Exception 2 to Section 160.3(b)5K: Multifamily dwelling units in buildings four habitable stories and greater in Climate Zones 1, 3, 5 and 7.

L. **System airflow rate and fan efficacy.** Space-conditioning systems that utilize forced air ducts to supply cooling to an individual dwelling unit shall:

i. **Static pressure probe.** Have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location and labeling of the HSPP or PSPP shall conform to the requirements specified in Reference Residential Appendix RA3.3.1.1 as confirmed by field verification and diagnostic testing; and

Exception to Section 160.3(b)5Li: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.3-1 shall not be required to provide holes as described in Figure RA3.3-1.

ii. **Single zone central forced air systems.** Demonstrate, in every control mode, airflow greater than or equal to 350 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in Subsection a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

a. 0.45 W/cfm for gas furnace air-handling units.

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

Exception 1 to Section 160.3(b)5Lii: Standard ducted systems without zoning dampers may comply by meeting the applicable requirements in Table 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 160.2(b)1Div for the system air filter(s) shall conform to the requirements given in Table 160.3-A or 160.3-B.

Exception 2 to Section 160.3(b)5Lii: Multispeed compressor systems or variable speed compressor systems shall verify airflow (cfm/ton) and fan efficacy (watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

Exception 3 to Section 160.3(b)5Lii: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

iii. **Zonally controlled central forced air systems.** Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 cfm per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to the maximum W/cfm specified in Subsection a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

a. 0.45 W/cfm for gas furnace air-handling units.

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

Exception 1 to Section 160.3(b)5Liii: Multispeed or variable speed compressor systems, with controls that vary fan speed subject to the number of zones, as certified by the installer may demonstrate compliance with the airflow (cfm/ton) and fan efficacy (watt/cfm) requirements of Section 160.3(b)5Liii by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning.

Exception 2 to Section 160.3(b)5Liii: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

iv. **Small duct high velocity forced air systems.** Demonstrate, in every control mode, airflow greater than or equal to 250 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to 0.62 W/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

Exception 1 to Section 160.3(b)5Liv: Standard ducted systems without zoning dampers may comply by meeting the applicable requirements in Table 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 160.2(b)1Div for the system air filter(s) shall conform to the requirements given in Table 160.3-A or 160.3-B.

Exception 2 to Section 160.3(b)5Liv: Multispeed compressor systems or variable speed compressor systems shall verify airflow (cfm/ton) and fan efficacy (watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

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Exception 1 to Section 160.3(b)5L: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

Exception 2 to Section 160.3(b)5L: Multifamily dwelling units in buildings four habitable stories and greater in Climate Zone 1.

6. Piping for space-conditioning systems, solar water-heating system collector loop, and distribution piping for steam and hydronic heating system shall meet the requirements of Section 160.3(c)1.
7. **Defrost**.
   A. If a heat pump is equipped with a defrost delay timer, the delay timer must be set to greater than or equal to 90 minutes.
   B. The installer shall certify on the Certificate of Installation that the control configuration has been tested in accordance with the testing procedure found in the Certificate of Installation.

   Exception to 160.3(b)7. Dwelling units in Climate Zones 1, 6 through 10, 15, and 16 shall not be required to comply with the 90-minute delay timer requirements.
8. **Capacity variation with third-party thermostats. Variable or multi-speed systems shall comply with the following requirements:**
   A. The space-conditioning system and thermostat together shall be capable of responding to heating and cooling loads by modulating system compressor speed.
   B. The installer shall certify on the Certificate of Installation that the control configuration has been tested in accordance with the testing procedure found in the Certificate of Installation.

(c) **Fluid distribution systems; common area space-conditioning systems.** Multifamily buildings shall comply with the applicable requirements of Section 160.3(a)1. Multifamily common areas shall comply with the applicable requirements of Sections 160.3(a)2A through 160.3(a)2J.

1. **Pipe insulation**. Multifamily buildings shall comply with the applicable requirements of Sections 160.3(c)1A through 160.3(c)1D.
   A. **General requirements.** The piping conditions listed below for space-conditioning systems with fluid normal operating temperatures listed in Table 160.3-D shall have at least the amount of insulation specified in Section 160.3(c)1D:
      i. **Space cooling systems.** All refrigerant suction, chilled water and brine fluid distribution systems.
      ii. **Space heating systems.** All refrigerant suction, steam, steam condensate and hot water fluid distribution systems.

      Exception to Section 160.3(c)1Aii: Heat pumps refrigerant vapor line shall be installed with a minimum of 0.75-inch-thick or R-6.0 insulation. No insulation is required on the refrigerant liquid line.
   B. Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in Table 160.3-D, and shall be rounded to the nearest $^{1}/_{100}$ Btu-inch per hour per square foot per °F. Fluid distribution systems include all elements that are in series with the fluid flow, such as pipes, pumps, valves, strainers, coil u-bends and air separators, but not including elements that are not in series with the fluid flow, such as expansion tanks, fill lines, chemical feeders and drains.
   C. **Insulation protection.** Pipe insulation shall be protected from damage due to sunlight, moisture, equipment maintenance and wind. Protection shall, at minimum, include the following:
      i. Pipe insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be used to provide this protection.
      ii. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.
      iii. Pipe insulation buried below grade must be installed in a waterproof and noncrushable casing or sleeve.
   D. **Insulation thickness.**
      i. For insulation with a conductivity in the range shown in Table 160.3-D for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or *R*-value shown in Table 160.3-D.
      ii. For insulation with a conductivity outside the range shown in Table 160.3-D for the applicable fluid temperature range, the insulation shall have a minimum *R*-value shown in Table 160.3-D or thickness as calculated with Equation 160.3-A:

      (Equation 160.3-A) $$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}}-1\right]$$

      where:

      T = Minimum insulation thickness for material with conductivity K, inches.

      PR = Pipe actual outside radius, inches.

t = Insulation thickness from 160.3-D, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in Table 160.3-D for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 160.3-D for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

Exception 1 to Section 160.3(c)1: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

Exception 2 to Section 160.3(c)1: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

Exception 3 to Section 160.3(c)1: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

Exception 4 to Section 160.3(c)1: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to ensure that no contact is made with the metal framing.

2. **Requirements for air distribution system, ducts and plenum.** Multifamily common areas shall comply with the applicable requirements of Sections 160.3(c)2A through 160.3(c)2F.

   A. **CMC compliance.** All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums shall meet the requirements of CMC Sections 601.0, 602.0, 603.0, 604.0 and 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.

   B. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

      i. Outdoors; or

      ii. In a space between the roof and an insulated ceiling; or

      iii. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or

      iv. In an unconditioned crawl space; or

      v. In other unconditioned spaces.

      Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 or be enclosed in directly conditioned space.

   C. **Duct and plenum materials.**

      i. Factory-fabricated duct systems.

         a. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

         b. All pressure-sensitive tapes, heat-activated tapes and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

         c. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

         d. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

            Exception to Section 160.3(c)2Cid: Ductwork located in occupied space and exposed to view.

      ii. Field-fabricated duct systems.

         a. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.

         b. Mastic sealants and mesh.

            I. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 181B, and be nontoxic and water resistant.

            II. Sealants for interior applications shall pass ASTM C731 (extrudability after aging) and D2202 (slump test on vertical surfaces), incorporated herein by reference.

            III. Sealants for exterior applications shall pass ASTM C731, C732 (artificial weathering test) and D2202, incorporated herein by reference.

            IV. Sealants and meshes shall be rated for exterior use.

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c. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.

d. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

e. Drawbands used with flexible duct.

I. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

II. Drawbands shall have a minimum tensile strength rating of 150 pounds.

III. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

f. Aerosol-sealant closures.

I. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

II. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

D. All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor retarders or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

E. The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

i. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

ii. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

iii. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

F. Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor retarder or other duct components), based on the tests in Section 160.3(c)2D and the installed thickness determined by Section 160.3(c)2Eiii.

G. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service; e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

H. Duct systems shall be tested in accordance with i or ii below:

i. New duct systems that meet the criteria in Subsections a, b and c below or ductwork that is part of a system that meets the criteria of Section 180.2(b)2B shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through acceptance testing, in accordance with Reference Nonresidential Appendix NA7.5.3.

a. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and

b. The space-conditioning system serves less than 5,000 square feet of conditioned floor area; and

c. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:

I. Outdoors; or

II. In a space directly under a roof that has a *U*-factor greater than the *U*-factor of the ceiling, or if the roof does not meet the requirements of Section 170.2(a)1; or

III. In a space directly under a roof that has fixed vents or openings to the outside or unconditioned spaces; or

IV. In an unconditioned crawl space; or

V. In other unconditioned spaces.

ii. All duct systems that do not meet the criteria in Section 160.3(c)2H shall meet the duct leakage testing requirements of CMC Section 603.9.2.

(d) **Mechanical acceptance testing.**

1. Common areas. Before an occupancy permit is granted, the following systems and equipment serving multifamily common areas shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by Reference Nonresidential Appendix NA7. These systems and equipment shall also comply with the applicable requirements of Section

160.3(d)3. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

A. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1.

B. Constant volume, single zone air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.

C. Duct systems shall be tested in accordance with NA7.5.3 where either:

a. They are new duct systems; or

b. They are part of an altered system.

D. Air economizers, DOAS, HRV or ERV systems shall be tested in accordance with NA7.5.4.

Exception to Section 160.3(d)1D: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are not required to comply with the Functional Testing section of the Air Economizer Controls acceptance test as described in NA7.5.4.2.

E. Demand control ventilation systems required by Section 160.2(c)3 shall be tested in accordance with NA7.5.5.

F. Supply fan variable flow controls shall be tested in accordance with NA7.5.6.

G. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9.

H. Boilers or chillers that require isolation controls as specified by Section 170.2(c)4Iii or 170.2(c)4Iiii shall be tested in accordance with NA7.5.7.

I. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8.

J. Automatic demand shed controls shall be tested in accordance with NA7.5.10.

K. Fault detection and diagnostics (FDD) for packaged direct expansion units shall be tested in accordance with NA7.5.11.

L. Automatic fault detection and diagnostics (FDD) for air handling units and zone terminal units shall be tested in accordance with NA7.5.12.

M. Distributed energy storage DX AC systems shall be tested in accordance with NA7.5.13.

N. Thermal energy storage (TES) systems shall be tested in accordance with NA7.5.14.

O. Supply air temperature reset controls shall be tested in accordance with NA7.5.15.

P. Water-cooled chillers served by cooling towers with condenser water reset controls shall be tested in accordance with NA7.5.16.

Q. When an energy management control system is installed, it shall functionally meet all of the applicable requirements of Part 6.

R. Occupant sensing zone controls shall be tested in accordance with NA7.5.17.

2. Multifamily dwelling units. Before an occupancy permit is granted, the following systems and equipment serving multifamily dwelling units shall be certified as meeting the acceptance requirements for code compliance, as specified by the Reference Nonresidential Appendix NA7. These systems and equipment shall also comply with the applicable requirements of Section 160.3(d)3. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

A. Multifamily building central ventilation ducts subject to Section 160.2(b)2C shall be leak tested in accordance with NA7.18.3.

B. Multifamily building central ventilation system heat recovery or energy recovery systems in multifamily buildings with four or more habitable stories shall be tested in accordance with NA7.18.4.

3. When certification is required by Title 24, Part 1, Section 10-103.2, the acceptance testing specified by Section 160.3(d)1 and 2 shall be performed by a Certified Mechanical Acceptance Test Technician (CMATT). If the CMATT is operating as an employee, the CMATT shall be employed by a Certified Mechanical Acceptance Test Employer. The CMATT shall disclose on the Certificate of Acceptance a valid CMATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CMATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

TABLE 160.3-A—RETURN DUCT SIZING FOR SINGLE RETURN DUCT SYSTEMS

Return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 160.2(b)1Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

SYSTEM NOMINAL COOLING CAPACITY (TON)*	RETURN DUCT MINIMUM NOMINAL DIAMETER (INCH)	MINIMUM TOTAL RETURN FILTER GRILLE NOMINAL AREA (INCH^2)
1.5	16	500
2.0	18	600
2.5	20	800

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton.

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TABLE 160.3-B—RETURN DUCT SIZING FOR MULTIPLE RETURN DUCT SYSTEMS

Each return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 160.2(b)1Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

SYSTEM NOMINAL COOLING CAPACITY (TON)*	RETURN DUCT 1 MINIMUM NOMINAL DIAMETER (INCH)	RETURN DUCT 2 MINIMUM NOMINAL DIAMETER (INCH)	MINIMUM TOTAL RETURN FILTER GRILLE NOMINAL AREA ($INCH^2$)
1.5	12	10	500
2.0	14	12	600
2.5	14	14	800
3.0	16	14	900
3.5	16	16	1000
4.0	18	18	1200
5.0	20	20	1500

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton.

TABLE 160.3-C—DDC APPLICATIONS AND QUALIFICATIONS

BUILDING STATUS	APPLICATIONS	QUALIFICATIONS
Newly Constructed Buildings	Air handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Newly Constructed Buildings	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
Newly Constructed Buildings	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV box	Where existing zones served by the same air handling, chilled water or hot water systems that have DDC
Additions or Alterations	Air handling system or fan coil	Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
Additions or Alterations	New air handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new
Additions or Alterations	New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger

TABLE 160.3-D—PIPE INSULATION THICKNESS REQUIRED (thickness in inches or R-value)

FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY			NOMINAL PIPE DIAMETER (in inches)				
	Conductivity (in Btu·in/h·ft^2· °F)	Mean Rating Temperature (°F)		< 1	1 to < 1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating (Steam, Steam Condensate, Refrigerant, Space Heating)				**Minimum Pipe Insulation Required (Thickness in inches or *R*-value)**				
Above 350	0.32–0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R-value	R-37	R-41	R-37	R-27	R-23
251–350	0.29–0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R-value	R-24	R-34	R-35	R-26	R-22
201–250	0.27–0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R-value	R-21	R-20	R-17.5	R-17	R-14.5
141–200	0.25–0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R-value	R-11.5	R-11	R-14	R-11	R-10
105–140	0.22–0.28	100	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R-7.7	R-12.5	R-11	R-9	R-8
40–60	0.21–0.27	75	Inches	0.75	0.75	1.0	1.0	1.0
			R-value	R-6	R-5	R-7	R-6	R-5

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TABLE 160.3-D—PIPE INSULATION THICKNESS REQUIRED (thickness in inches or R-value)—continued								
FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY			NOMINAL PIPE DIAMETER (in inches)				
	Conductivity (in Btu·in/h·ft²· °F)	Mean Rating Temperature (°F)		< 1	1 to < 1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating (Steam, Steam Condensate, Refrigerant, Space Heating)				Minimum Pipe Insulation Required (Thickness in inches or *R*-value)				
Below 40	0.20–0.26	50	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R-8.5	R-14	R-12	R-10	R-9
1. These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.								

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.4—MANDATORY REQUIREMENTS FOR WATER-HEATING SYSTEMS

(a) Water-heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 110.3(c)4.

(b) Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or a listing agency that is approved by the Executive Director.

(c) Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)6.

(d) **Commercial boilers**

1. Combustion air positive shut-off shall be provided on all newly installed boilers as follows:
   A. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
   B. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).
2. Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:
   A. The fan motor shall be driven by a variable speed drive, or
   B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.
3. Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

   Exception to Section 160.4(d)3: Boilers with steady state full-load thermal combustion efficiency 90 percent or higher.

(e) **Pipe insulation**

All piping for multifamily domestic hot water systems shall be insulated and meet the applicable requirements in Items 1 through 3 below:

1. **General requirements.**
   A. The first 8 feet of inlet cold water piping from the storage tanks, including piping between a storage tank and a heat trap, shall be insulated.
   B. Insulation on the piping and domestic hot water system appurtenances shall be continuous.
   C. Pipe supports, hangers, and pipe clamps shall be attached on the outside of rigid pipe insulation to prevent thermal bridges.
   D. All pipe insulation seams shall be sealed.
   E. Insulation for pipe elbows shall be mitered, preformed, or site fabricated with PVC covers.
   F. Insulation for tees shall be notched, preformed, or site fabricated with PVC covers.
   G. Extended stem isolation valves shall be installed.
   H. All plumbing appurtenances on hot water piping from a heating source to heating plant, at the heating plant, and distribution supply and return piping shall be insulated to meet the following requirements:
      i. Where the outer diameter of the appurtenance is less than the outer diameter of the insulated pipe that it is attached to, the appurtenance shall be insulated flush with the insulation surrounding the pipe.
      ii. Where the outer diameter of the appurtenance is greater than the outer diameter of the insulated pipe that it is attached to, the appurtenance shall be insulated with a minimum thickness of 1 inch.
      iii. The insulation shall be removable and re-installable to ensure maintenance or replacement services can be completed.
      iv. Valves shall be fully functional without impediment from the insulation.

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2. **Insulation thickness.** All piping for multifamily domestic hot water systems shall meet the insulation thickness requirements specified in Table 160.4-A.
   A. For insulation conductivity in the range shown in Table 160.4-A for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or *R*-value shown in Table 160.4-A.
   B. If the insulation conductivity falls outside the range provided in Table 160.4-A applicable fluid temperature range, the insulation shall meet a minimum *R*-value as indicated in Table 160.4-A. Or, it can have a thickness determined using Equation 160.4-A.

(Equation 160.4-A) $$T = PR\left[\left(1 + \frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

where:

T = Minimum insulation thickness for material with conductivity K, inches.

PR = Pipe actual outside radius, inches.

t = Insulation thickness from Table 160.4-A, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in Table 160.4-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 160.4-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

   C. Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in Table 160.4-A and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

Exception 1 to Section 160.4(e): Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to ensure that no contact is made with the metal framing. Insulation shall abut securely against all framing members.

Exception 2 to Section 160.4(e): Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with quality insulation installation (QII) as specified in Reference Residential Appendix RA3.5.

Exception 3 to Section 160.4(e): Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawl space insulation or 4 inches of attic insulation shall not be required to have pipe insulation.

TABLE 160.4-A—PIPE INSULATION THICKNESS—MULTIFAMILY DOMESTIC HOT WATER

FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY			NOMINAL PIPE DIAMETER (in inches)				
	Conductivity (in Btu·in/h·ft²· °F)	Mean Rating Temperature (°F)		< 1	1 to < 1.5	1.5 to < 4	4 to < 8	8 and larger
Multifamily Domestic Hot Water Systems				Minimum Pipe Insulation Required (Thickness in inches or *R*-value)				
105–140[1]	0.22–0.28	100	Inches	1.0	1.5	2.0	2.0	2.0
			R-value	R7.7	R12.5	R16	R12.5	R11

1. Multifamily and hotel/motel domestic hot water systems with water temperature above 140°F shall use the row in Table 120.3-A for the applicable water temperature.

3. **Insulation protection.** Pipe insulation shall be protected from damage due to sunlight, moisture, equipment maintenance and wind. Protection shall, at minimum, include the following:
   A. Pipe and appurtenance insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Appurtenance insulation covers shall be removable and able to be reinstalled. Adhesive tape shall not be used to provide this protection.
   B. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.
   C. Pipe insulation buried below grade must be installed in a waterproof and noncrushable casing or sleeve.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.5—MANDATORY LIGHTING REQUIREMENTS FOR INDOOR AND OUTDOOR SPACES

The design and installation of all lighting systems and equipment in multifamily buildings within the scope of Section 100.0(a) shall comply with the applicable provisions of Section 160.5. All functional areas except dwelling units and common living areas shall comply with the applicable requirements of Sections 160.5(b) through 160.5(e).

(a) **Dwelling unit lighting.** The design and installation of all lighting systems and equipment in multifamily dwelling units shall comply with Section 160.5(a). Multifamily dwelling units include dormitory and senior housing dwelling accommodations. Outdoor lighting attached to multifamily buildings and controlled from the inside of a dwelling unit shall comply with the lighting requirements of Section 160.5(a).

1. Luminaire requirements.
   A. **Luminaire efficacy.** All installed luminaires and light sources shall comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.

      Exception 1 to Section 160.5(a)1A: **Integrated device lighting:** Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, garage door openers, and ceiling fan kits that are subject to DOE's Appliance and Equipment Standards Program.

      Exception 2 to Section 160.5(a)1A: Navigation lighting rated less than 5 watts, such as night lights, step lights, and path lights.

      Exception 3 to Section 160.5(a)1A: Cabinet lighting: Lighting with an efficacy of 45 lumens per watt or greater and located internal to drawers, cabinetry, and linen closets.

      Exception 4 to Section 160.5(a)1A: Light sources as follows:

      i. LED light sources installed outdoors;

      ii. Inseparable solid state lighting (SSL) luminaires containing colored light sources that are installed to provide decorative lighting;

      iii. High-intensity discharge (HID) light sources, including pulse start metal halide and high-pressure sodium light sources; and

      iv. Luminaires with hardwired high-frequency generator and induction lamp.

   B. Reserved.

   C. **Recessed downlight luminaires.** In addition to complying with Section 160.5(a)1A, luminaires recessed into ceilings shall meet all of the following requirements:

      i. Shall not contain screw base lamp sockets; and

      ii. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 cfm at 75 Pascals when tested in accordance with ASTM E283. An exhaust fan housing with integral light shall not be required to be certified airtight; and

      iii. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk, or be installed per manufacturer's instructions to maintain airtightness between the luminaire housing and ceiling; and

      iv. Meet the clearance and installation requirements of *California Electrical Code* Article 410.116 for recessed luminaires.

      Exception to Section 160.5(a)1Cii and Iii: Recessed luminaires marked for use in fire-rated installations, and recessed luminaires installed in noninsulated ceilings.

   D. **Light sources in enclosed or recessed luminaires.** Lamps and other separable light sources in enclosed or recessed luminaires shall be in compliance with the JA8 elevated temperature requirements, including marking requirements.

   E. **Blank electrical boxes.** The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes shall be served by a dimmer, vacancy sensor control, low voltage wiring or fan speed control.

2. **Indoor lighting controls.**
   A. Lighting shall have readily accessible wall-mounted controls that allow the lighting to be manually turned ON and OFF.

      Exception to Section 160.5(a)2A: Ceiling fans may provide control of integrated lighting via a remote control.

   B. Reserved.

   C. **All lighting controls.** Lighting controls shall comply with the applicable requirements of Section 110.9.

   D. **Controls permitted.** An energy management control system (EMCS) or a multiscene programmable controller may be used to comply with dimming, occupancy and lighting control requirements in Section 160.5(a)2 if it provides the functionality of the specified controls in accordance with Section 110.9 and the physical controls specified in Section 160.5(a)2A. No controls shall bypass control functions of a dimmer, occupant sensor, or vacancy sensor where the dimmer or sensor has been installed to comply with Section 160.5(a)2.

   E. **Automatic-off controls.**

      i. In bathrooms, garages, laundry rooms, utility rooms and walk-in closets, at least one installed luminaire shall be controlled by an occupancy or vacancy sensor providing automatic-off functionality.

      ii. For lighting internal to drawers and cabinetry with opaque fronts or doors, controls that turn the lighting off when the drawer or door is closed shall be provided.

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F. **Dimming controls.** Lighting in habitable spaces, including living rooms, dining rooms, kitchens and bedrooms, shall have readily accessible wall-mounted dimming controls that allow the lighting to be manually adjusted up and down. Forward phase cut dimmers controlling LED light sources shall comply with NEMA SSL 7A.

Exception 1 to Section 160.5(a)2F: Ceiling fans may provide control of integrated lighting via a remote control. Lighting integral to kitchen range hoods and bathroom exhaust fans.

Exception 2 to Section 160.5(a)2F: Luminaires controlled by an occupancy or vacancy sensor providing automatic-off functionality.

Exception 3 to Section 160.5(a)2F: Navigation lighting rated less than 5 watts, such as night lights, step lights and path lights. Lighting controlled by automatic-off controls and located internal to drawers, cabinetry with opaque fronts, or cabinetry with doors.

G. **Independent controls.** Lighting integrated with the exhaust fans shall be controlled independently from the fans. The following shall be controlled separately from ceiling-installed lighting such that one can be turned on without turning on the other:

i. Undercabinet lighting
ii. Undershelf lighting
iii. Interior lighting of display cabinets
iv. Switched outlets

3. **Outdoor lighting controls.** In addition to meeting the requirements of Section 160.5(a)1, luminaires providing residential outdoor lighting shall meet the following requirements, as applicable:

A. Outdoor lighting attached to a building and separately controlled from the inside of a dwelling unit shall meet the following requirements:

i. Controlled by a manual ON and OFF control switch that permits the automatic actions of Item ii or iii below; and
ii. Controlled by one of the following controls:
a. A photocell and a motion sensor; or
b. A photocell and an automatic time switch control; or
iii. Controlled by an astronomical time clock control.

B. Controls that override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within six hours.

C. An energy management control system (EMCS) or other controls that provide the specified lighting control functionality and complies with all requirements applicable to the specified controls may be used to meet these requirements.

(b) **Common use services lighting.** Lighting systems and equipment in multifamily common services use areas shall comply with the applicable provisions of Sections 160.5(b)1 through 160.5(b)4.

Exception to Section 160.5(b): Lighting systems in common use areas providing shared provisions for living, eating, cooking or sanitation to dwelling units that would otherwise lack these provisions may instead comply with Section 160.5(a).

NOTE: The requirements of Section 160.5(b) apply to newly constructed buildings. Sections 180.1 and 180.2 specify which requirements of Sections 160.5(b)1 through 160.5(e) also apply to additions and alterations to existing buildings.

1. **Luminaire classification and power.** Luminaires shall be classified and their wattage determined as follows:

A. Luminaire wattage shall be labeled as follows:

i. The maximum rated wattage or relamping rated wattage of a luminaire shall be listed on a permanent, preprinted, factory-installed label, as specified by UL 1574, 1598, 2108 or 8750, as applicable; and
ii. The factory-installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the luminaire has been shipped from the manufacturer.

Exception to Section 160.5(b)1Aii: Luminaires with a single lamp and an integrated ballast or transformer may use a peel-down label provided that they are layered such that the rated wattage reduces as successive layers are removed.

a. Low-voltage luminaires (except low voltage track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.
b. Compact fluorescent luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.
c. High-intensity discharge luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.

B. For luminaires with line voltage lamps not served by drivers, ballasts or transformers, the wattage of such luminaires shall be determined as the maximum rated wattage as labeled in accordance with Section 160.5(b)1A.

C. For luminaires with permanently installed or remotely installed ballasts, the wattage of such luminaires shall be the operating input wattage of the rated lamp/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by UL 1598.

D. For inseparable SSL luminaires and SSL luminaires with remotely mounted drivers, the maximum rated wattage shall be the maximum rated input wattage of the SSL luminaire as specified in Section 160.5(b)1A when tested in accordance with UL 1598, 2108 or 8750, or IES LM-79.

E. For LED tape lighting and LED linear lighting with LED tape lighting components, the maximum rated wattage shall be the sum of the installed length of the tape lighting times its rated linear power density in watts per linear foot, or the maximum rated input wattage of the driver or power supply providing power to the lighting system, with tape lighting tested in accordance with UL 2108 or 8750, or IES LM-79.

F. For modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the system, wattage shall be determined as follows:

i. The wattage shall be the greater of:

a. 30 watts per linear foot of track or plug-in busway; or

b. The rated wattage of all of the luminaires included in the system, where the luminaire wattage is determined as specified in Section 160.5(b)1A; or

ii. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:

a. The volt-ampere rating of current limiter as specified by UL 1077; or

b. The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for track lighting supplementary overcurrent protection panel.

iii. For other modular lighting systems with power supplied by a driver, power supply or transformer, including but not limited to low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformer published in the manufacturer's catalogs, as specified by UL 2108 or 8750.

Exception to Section 160.5(b)1F: For power-over-Ethernet lighting systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

G. For all other lighting equipment not addressed by Sections 160.5(b)1B through F, the wattage of the lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, labeled in accordance with Section 160.5(b)1A, or published in manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574, 1598, 2108 or 8750, or IES LM-79.

2. **Lighting controls**. All lighting controls and equipment shall comply with the applicable requirements in Sections 110.9, 160.5(b) and 160.5(c), and shall be installed in accordance with any applicable manufacturer instructions.

3. **Energy management control system (EMCS)**. An EMCS may be installed to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:

A. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Sections 110.9, 160.5(b) and 160.5(c); and

B. Complies with all applicable lighting control installation requirements in accordance with Section 160.5(e) for each specific lighting control or system for which it is installed; and

C. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.

4. **Mandatory indoor lighting controls**. Multifamily common use areas shall comply with the applicable requirements of Sections 160.5(b)4A through 160.5(b)4F, in addition to the applicable requirements of Section 110.9.

A. **Manual controls.** Each space shall be provided with lighting controls that allow the lighting in that space to be manually turned on and off. The manual control shall:

i. Be readily accessible; and

Exception to Section 160.5(b)4Ai: Restrooms having two or more stalls, parking areas, stairwells, corridors and spaces of the building intended for access or use by the public may use a manual control not accessible to unauthorized personnel.

ii. Be located in the same space or be located such that the controlled lighting or the status of the controlled lighting can be seen when operating the controls; and

iii. Provide separate control of general, floor display, wall display, window display, case display, ornamental and special effects lighting, such that each type of lighting can be turned on or off without turning on or off other types of lighting. Scene controllers may comply with this requirement provided that at least one scene turns on general lighting only, and the control provides a means to manually turn off all lighting.

Exception to Section 160.5(b)4A: Up to 0.1 watts per square foot of indoor lighting may be continuously illuminated to allow for means of egress illumination consistent with *California Building Code* Section 1008. Egress lighting complying with this wattage limitation is not required to comply with manual area control requirements if:

i. The space is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1; and

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ii. The egress lighting controls shall not be controllable by unauthorized personnel during a normal power failure.

B. **Multi-level lighting controls.** The general lighting of any space with a size of 100 square feet or larger and with a connected lighting load greater than 0.5 watts per square foot shall be provided with multilevel lighting controls. The multilevel lighting controls shall provide and enable continuous dimming from 100 percent to 10 percent or lower of lighting power.

Exception 1 to Section 160.5(b)4B: An indoor space that has only one luminaire.

Exception 2 to Section 160.5(b)4B: Restrooms.

Exception 3 to Section 160.5(b)4B: The general lighting with light source of HID and induction shall have a minimum of one control step between 30 and 70 percent of full rated power.

C. **Shut-OFF controls.** All installed indoor lighting shall be equipped with controls able to automatically reduce lighting power when the space is typically unoccupied.

Exception to Section 160.5(b)4C: Continuous illumination of up to 0.1 watts per square foot of lighting is allowed to be in any area designated for egress within a building, provided that the area is indicated on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1. Lighting providing means of egress illumination, as defined in the *California Building Code*, shall be configured to provide no less than the illumination required by *California Building Code* Section 1008 while in the partial-off mode.

i. All installed indoor lighting shall be equipped with controls that meet the following requirements:

a. Shall be controlled with an occupant sensing control set no more than a 20-minute time delay, automatic time-switch control or other control capable of automatically shutting OFF all of the lighting when the space is typically unoccupied; and

b. Separate controls for the lighting on each floor, other than lighting in stairwells; and

c. Separate control zones for a space enclosed by ceiling height partitions not exceeding 5,000 square feet.

Exception 1 to Section 160.5(b)4Ci: Where the lighting is serving an area that is in continuous use, 24 hours per day/365 days per year.

Exception 2 to Section 160.5(b)4Ci: Lighting complying with Section 160.5(b)4Cv or Section 160.5(b)4Cvic.

Exception 3 to Section 160.5(b)4Ci: Electrical equipment rooms subject to Article 110.26(D) of the *California Electrical Code*.

Exception 4 to Section 160.5(b)4Ci: Illumination provided by lighting equipment that is designated for emergency lighting, and intended to function in emergency mode only when normal power is absent.

ii. Countdown timer switches may be used to comply with the automatic shut-OFF control requirements in Section 160.5(b)4Ci only in closets less than 70 square feet. The maximum timer setting shall be 10 minutes for closets.

iii. If an automatic time-switch control is installed to comply with Section 160.5(b)4Ci, it shall incorporate a manual override lighting control that allows the lighting to remain on for no more than 2 hours when an override is initiated.

Exception to Section 160.5(b)4Ciii: Areas where occupant sensing controls are installed.

iv. If an automatic time-switch control is installed to comply with Section 160.5(b)4Ci, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

Exception 1 to Section 160.5(b)4Civ: Automatic holiday shut-OFF features are not required in restaurants.

Exception 2 to Section 160.5(b)4Civ: Areas where occupant sensing controls are installed.

v. **Occupant sensing controls.** In offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, conference rooms, and restrooms, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting in 20 minutes or less after the control zone is unoccupied.

In areas required by Section 160.5(b)4B to have multi-level lighting controls, the occupant sensing controls shall function either as:

a. A partial-ON occupant sensing control capable of automatically activating between 50 and 70 percent of controlled lighting power, or

b. A vacancy sensing control, where all lighting responds to a manual ON input only.

In areas not required by Section 160.5(b)4B to have multi-level lighting controls, the occupant sensing controls shall function either as:

a. An automatic full-on occupant sensing control; or

b. A partial-ON occupant sensing control, or

c. A vacancy sensing control, where all lighting responds to a manual ON input only.

In addition, controls shall be provided that allow the lights to be manually shut OFF in accordance with Section 160.5(b)4A regardless of the sensor status.

vi. **Full or partial OFF occupant sensing controls.** For corridors, stairwells, and offices greater than 250 square feet, parking garages, parking areas, loading areas, and unloading areas, the installed lighting shall meet the following requirements:

a. In corridors and stairwells, lighting shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

b. In office spaces greater than 250 square feet, general lighting shall be controlled by occupancy sensing controls that meet all of the following:

I. The occupancy sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. All control zones in offices greater than 250 square feet shall be shown on the plans; and

II. In 20 minutes or less after the control zone is unoccupied, the occupancy sensing controls shall uniformly reduce lighting power in the control zone to no more than 20 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and

III. In 20 minutes or less after the entire office space is unoccupied, the occupancy sensing controls shall automatically turn off lighting in all control zones in the space; and

IV. In each control zone, lighting shall be allowed to automatically turn on to any level up to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the space, the lighting in other control zones that are unoccupied shall operate at no more than 20 percent of full power.

Exception to Section 160.5(b)4Cvib: Under-shelf or furniture-mounted task lighting controlled by a local switch and either a time switch or an occupancy sensor.

c. In parking garages, parking areas, and loading and unloading areas, general lighting shall be controlled by occupant sensing controls that meet the requirements below instead of complying with Section 160.5(b)4Ci:

i. The occupant sensing controls shall uniformly reduce lighting power in the control zone to between 20 percent and 50 percent of full power and with at least one control step; and

ii. No more than 500 watts of rated lighting power shall be controlled together as a single zone; and

iii. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled zone and shall be automatically activated from all designed paths of egress.

Interior areas of parking garages are under the classification of indoor lighting and shall comply with Section 160.5(b)4Cvic. Parking areas on the roof of a parking structure are under the classification of outdoor hardscape and shall comply with Section 160.5(c).

D. **Daylight responsive controls.** Daylight responsive controls shall be installed in the following locations, as applicable:

i. In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within skylit daylit zones is 75 watts or greater, the general lighting in the skylit daylit zones shall be controlled by daylight responsive controls.

ii. In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within primary sidelit daylit zones is 75 watts or greater, the general lighting in the primary sidelit daylit zones shall be controlled by daylight responsive controls.

iii. In any enclosed space where the total wattage of general lighting luminaires in the secondary zones is 75 watts or greater, the general lighting in the secondary sidelit daylit zones shall be controlled by daylight responsive controls. General lighting in the secondary sidelit daylit zones shall be controlled independently of general lighting in the primary sidelit daylit zones.

iv. For skylights located in an atrium, the skylit daylit zones shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

v. Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is 60 watts or greater, the general lighting in the primary and secondary sidelit daylit zones shall be controlled by daylight responsive controls.

All daylight responsive controls shall meet the following requirements:

vi. All skylit daylit zones, primary sidelit daylit zones, secondary sidelit daylit zones and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans; and

NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

vii. The daylight responsive controls shall provide separate control for general lighting in each type of daylit zone. The daylight responsive controls shall meet the following:

a. General lighting in overlapping skylit daylit zone and sidelit daylit zone shall be controlled as part of the skylit daylit zone.

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b. General lighting in overlapping primary and secondary sidelit daylit zone shall be controlled as part of the primary sidelit daylit zone.

c. General lighting luminaires longer than 8 feet shall be controlled as segments of 8 feet or less according to the type of the daylit zone where the segment is primarily located; and

Exception to Section 160.5(b)4Dviic: Where a luminaire contains a factory-assembled housing and light source as an integral unit in segments longer than 8 feet, the luminaire is allowed to be controlled according to the type of the daylit zone in which the segment is primarily located.

viii. The daylight responsive controls shall meet the following:

a. For spaces where the installation of multilevel lighting controls is required under Section 160.5(b)4B, allow the multilevel lighting controls to adjust the light level with continuous dimming;

b. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

c. For areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting system when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and

d. For parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylight zones shall be reduced by 100 percent; and

ix. Photosensors shall be located so that they are not readily accessible to unauthorized personnel; and

x. The location where calibration adjustments are made to the daylight responsive controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover that requires a tool for access; and

xi. Interaction with other lighting controls in a space where manual controls are required, the manual controls shall be capable of turning off or decreasing light levels below the light level set by the daylight responsive controls.

Exception 1 to Section 160.5(b)4D: Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

Exception 2 to Section 160.5(b)4D: Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for south, east and west orientations or greater than 1 for north orientations.

Exception 3 to Section 160.5(b)4D: Where daylight responsive controls are not required for the primary sidelit daylit zones, and where the total wattage of general lighting luminaires in the secondary sidelit daylit zones is less than 85 watts, daylight responsive controls are not required for the secondary sidelit zone.

Exception 4 to Section 160.5(b)4D: Reserved.

Exception 5 to Section 160.5(b)4D: Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

Exception 6 to Section 160.5(b)4D: For parking garages, luminaires located in the daylight adaptation zone.

Exception 7 to Section 160.5(b)4D: Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

E. **Demand responsive controls.** See Section 110.12 for requirements for demand responsive lighting controls.

F. **Occupancy sensing controls interactions with space-conditioning systems.** For space-conditioning system zones serving only spaces that are required to have occupancy sensing controls as specified in Sections 160.5(b)4Cv and vi, and where Table 120.1-A allows the ventilation air to be reduced to zero when the space is in occupied-standby mode, the space-conditioning system shall be permitted to be controlled by occupancy sensing controls as specified in Section 120.2(e)3.

(c) **Outdoor lighting and control equipment.** Multifamily buildings shall comply with the applicable requirements of Sections 160.5(c)1 through 160.5(c)2.

1. **Luminaire shielding requirements.** All outdoor luminaires of 6,200 initial luminaire lumens or greater shall comply with backlight, uplight, and glare (BUG) (in accordance with ANSI/IES TM-15-20, Annex A) requirements in accordance with Title 24, Part 11, Section 5.106.8.

Exception 1 to Section 160.5(c)1: Signs.

Exception 2 to Section 160.5(c)1: Lighting for building facades, public monuments, public art, statues and vertical surfaces of bridges.

Exception 3 to Section 160.5(c)1: Lighting not permitted by a health or life safety statute, ordinance or regulation to be a cutoff luminaire.

Exception 4 to Section 160.5(c)1: Temporary outdoor lighting**.**

Exception 5 to Section 160.5(c)1: Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 160.5(c)1; and
B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and
C. Where no additional poles are being added to the site; and
D. Where new wiring to the luminaires is not being installed; and
E. Provided that the connected lighting power wattage is not increased.

Exception 6 to Section 160.5(c)1: Luminaires that illuminate the public right of way, including publicly maintained or utility-maintained roadways, sidewalks and bikeways.

Exception 7 to Section 160.5(c)1: Outdoor lighting attached to a multifamily building and separately controlled from the inside of a dwelling unit.

Exception 8 to Section 160.5(c)1: Luminaires that qualify as exceptions in Sections 5.106.8 of Part 11 of Title 24 and in Section 170.2(e)6A.

2. **Controls for outdoor lighting.** Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

Exception 1 to Section 160.5(c)2: Outdoor lighting not permitted by a health or life safety statute, ordinance or regulation to be turned OFF or reduced.

Exception 2 to Section 160.5(c)2: Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

A. **Daylight availability.** All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.
B. **Automatic scheduling controls.**
   i. Automatic scheduling controls shall be installed for all outdoor lighting. Automatic scheduling controls may be installed in combination with motion sensing controls or other outdoor lighting controls.
   ii. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by 50 to 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.
   iii. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels, and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than 2 hours when an override is initiated.
C. **Motion sensing controls**.
   i. Motion sensing controls shall be installed for outdoor luminaires providing lighting for general hardscape, parking lots, and outdoor canopies, where the bottom of the luminaire is mounted 24 feet above grade or lower.
   ii. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by 50 to 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.
   iii. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.
   iv. No more than 1,500 watts of lighting power shall be controlled by a single sensor or as a single zone.

   Exception 1 to Section 160.5(c)2C: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

   Exception 2 to Section 160.5(c)2C: Applications listed as exceptions to Section 170.2(e)2A and luminaires providing lighting for building façade, ornamental hardscape or outdoor dining are not required to have motion sensing controls.

   Exception 3 to Section 160.5(c)2C: Lighting subject to a health or life safety statute, ordinance or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

(d) **Sign lighting controls.** All sign lighting shall meet the requirements below as applicable:

1. **Indoor signs.** All indoor sign lighting other than exit sign lighting shall be controlled with an automatic time-switch control or astronomical time-switch control.
2. **Outdoor signs.** Outdoor sign lighting shall meet the following requirements as applicable:
   A. All outdoor sign lighting shall be controlled with a photocontrol in addition to an automatic time-switch control, or an astronomical time-switch control.

   Exception to Section 160.5(d)2A: Outdoor signs in tunnels, and signs in large permanently covered outdoor areas that are intended to be continuously lit, 24 hours per day and 365 days per year.
   B. All outdoor sign lighting that is ON both day and night shall be controlled with a dimmer that provides the ability to automatically reduce sign lighting power by a minimum of 65 percent during nighttime hours. Signs that are illuminated at night and for more than 1 hour during daylight hours shall be considered ON both day and night.

Exception to Section 160.5(d)2B: Outdoor signs in tunnels and large covered areas that are intended to be illuminated both day and night.

3. **Demand responsive electronic message center (EMC) control.** See Section 110.12 for requirements for demand responsive EMC controls.

(e) **Lighting control acceptance and installation certificate requirement.** Multifamily common use areas shall comply with the applicable requirements of Sections 160.5(e)1 through 160.5(e)3.

1. **Lighting control acceptance requirements.** Before an occupancy permit is granted, indoor and outdoor lighting controls serving the building, area or site and installed to comply with Section 160.5(b)4D, 160.5(b)4C, 160.5(b)4E, 160.5(c)2 or 170.2(e)1Aiij shall be certified as meeting the Acceptance Requirements for Code Compliance as specified by Reference Nonresidential Appendix NA7.6 and NA7.8. A Certificate of Acceptance shall be submitted to the enforcement agency under Section 10-103(a) of Part 1 that the equipment and systems meet the acceptance requirements:
   A. Reserved;
   B. Reserved;
   C. Daylight responsive controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.1;
   D. Lighting shut-OFF controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.2;
   E. Demand responsive lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.3; and
   F. Outdoor lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.8; and
   G. Lighting systems receiving the Institutional Tuning Power Adjustment Factor shall be tested in accordance with Reference Nonresidential Appendix NA7.6.4.
   H. Demand responsive controls required to control controlled receptacles shall be tested in accordance with Reference Nonresidential Appendix NA7.6.5.
2. **Lighting control installation certificate requirements.** To be recognized for compliance with Part 6, an Installation Certificate shall be submitted in accordance with Section 10-103(a) for any lighting control system, energy management control system, interlocked lighting system, lighting power adjustment factor, or additional wattage available for a videoconference studio, in accordance with the following requirements, as applicable:
   A. Certification that when a lighting control system is installed to comply with lighting control requirements in Part 6, it complies with the applicable requirements of Section 110.9 and complies with Reference Nonresidential Appendix NA7.7.1.
   B. Certification that when an energy management control system is installed to function as a lighting control required by Part 6, it functionally meets all applicable requirements for each application for which it is installed, in accordance with Sections 110.9, 160, 170 and 180, and complies with Reference Nonresidential Appendix NA7.7.2.
   C. Certification that interlocked lighting systems used to serve an approved area comply with Section 170.2(e)2A and comply with Reference Nonresidential Appendix NA7.7.4.
   D. Certification that lighting controls installed to earn a lighting power adjustment factor (PAF) comply with Section 170.2(e)2B and comply with Reference Nonresidential Appendix NA7.7.5.
   E. Reserved.
3. When certification is required by Title 24, Part 1, Section 10-103.1, the acceptance testing specified by Section 160.5(e) shall be performed by a Certified Lighting Controls Acceptance Test Technician (CLCATT). If the CLCATT is operating as an employee, the CLCATT shall be employed by a Certified Lighting Controls Acceptance Test Employer. The CLCATT shall disclose on the Certificate of Acceptance a valid CLCATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CLCATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.6—MANDATORY REQUIREMENTS FOR ELECTRIC POWER DISTRIBUTION SYSTEMS

Multifamily buildings shall comply with the applicable requirements of Sections 160.6(a) through 160.6(e).

(a) **Service electrical metering.** Each electrical service or feeder that provides power to the common use areas (interior and exterior) shall have a permanently installed metering system that measures electrical energy use in accordance with Table 160.6-A.

Exception to Section 160.6(a): Service or feeder for which the utility company provides a metering system for the multifamily building that indicates instantaneous kW demand and kWh for a utility-defined period.

TABLE 160.6-A—MINIMUM REQUIREMENTS FOR METERING OR SUBMETERING OF ELECTRICAL LOAD				
METERING FUNCTIONALITY	**ELECTRICAL SERVICES[1] RATED 50 KVA OR LESS**	**ELECTRICAL SERVICES[1] RATED MORE THAN 50 KVA AND LESS THAN OR EQUAL TO 250 KVA**	**ELECTRICAL SERVICES[1] RATED MORE THAN 250 KVA AND LESS THAN OR EQUAL TO 1000 KVA**	**ELECTRICAL SERVICES[1] RATED MORE THAN 1000 KVA**
Instantaneous (at the time) kW demand	Required	Required	Required	Required
Historical peak demand (kW)	Not required	Not required	Required	Required
Tracking kWh for a user-definable period	Required	Required	Required	Required
kWh per rate period	Not required	Not required	Not required	Required
1. "Electrical services" applies to the building service-entrance rating or to the submetering service. For a building with submetering, this applies to the submetering service size to the common use areas.				

(b) **Separation of electrical circuits for electrical energy monitoring**. Electrical power distribution systems shall be designed so that measurement devices can monitor the electrical energy usage of load types according to Table 160.6-B.

Exception 1 to Section 160.6(b): For each separate load type, up to 10 percent of the connected load may be of any type.

Exception 2 to Section 160.6(b): Submetered electrical power distribution systems that provide power to dwelling units.

TABLE 160.6-B—MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD				
ELECTRICAL LOAD TYPE	**ELECTRICAL SERVICES[1] RATED 50 KVA OR LESS**	**ELECTRICAL SERVICES[1] RATED MORE THAN 50 KVA AND LESS THAN OR EQUAL TO 250 KVA**	**ELECTRICAL SERVICES[1] RATED MORE THAN 250 KVA AND LESS THAN OR EQUAL TO 1000 KVA**	**ELECTRICAL SERVICES[1] RATED MORE THAN 1000 KVA**
Lighting including exit and egress lighting and exterior lighting	Not required	All lighting in aggregate	All lighting disaggregated by floor, type or area	All lighting disaggregated by floor, type or area
HVAC systems and components including chillers, fans, heaters, furnaces, package units, cooling towers and circulation pumps associated with HVAC	Not required	All HVAC in aggregate	All HVAC in aggregate and each HVAC load rated at least 50 kVA	All HVAC in aggregate and each HVAC load rated at least 50 kVA
Domestic and service water system pumps and related systems and components	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Plug load including appliances rated less than 25 kVA	Not required	All plug load in aggregate Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area All groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf
Elevators, escalators, moving walks and transit systems	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Renewable power source (net or total)	Each group	Each group	Each group	Each group
Loads associated with renewable power source	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Charging stations for electric vehicles	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate
1. "Electrical services" applies to the building service-entrance rating or to the submetering service. For a building with submetering, this applies to the submetering service size to the common use areas.				

(c) **Voltage drop.** The maximum combined voltage drop on both installed feeder conductors and branch circuit conductors to the farthest connected load or outlet shall not exceed 5 percent.

Exception to Section 160.6(c): Voltage drop permitted by *California Electrical Code* Sections 647.4, 695.6 and 695.7.

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(d) **Circuit controls for 120-volt receptacles and controlled receptacles**. In all common areas, both controlled and uncontrolled 120 volt receptacles shall be provided in office areas, lobbies, conference rooms, kitchen areas in office spaces, and copy rooms. Plug-in strips and other plug-in devices shall not be used to comply with the requirements of this section.

Controlled receptacles shall meet the following requirements, as applicable:

1. Install a control capable of automatically shutting OFF the controlled receptacles when the space is typically unoccupied, either at the receptacle or circuit level. When an automatic time switch control is installed it shall incorporate an override control that allows the controlled receptacle to remain ON for no more than 2 hours when an override is initiated and an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours and then resumes the normally scheduled operation. Countdown timer switches shall not be used to comply with the automatic time switch control requirements; and
2. Install at least one controlled receptacle within 6 feet from each uncontrolled receptacle, or install a multiple receptacle outlet with at least one controlled and one uncontrolled receptacle. Where receptacles are installed in modular furniture in open office areas, at least one controlled receptacle shall be installed at each workstation; and
3. Provide a permanent marking for controlled receptacles or circuits to differentiate them from uncontrolled receptacles or circuits; and

Exception 1 to Section 160.6(d): Receptacles that are only for the following purposes:

A. Receptacles specifically for refrigerators and water dispensers in kitchen areas.
B. Receptacles located a minimum of 6 feet above the floor that are specifically for clocks.
C. Receptacles for network copiers, fax machines, A/V and data equipment other than personal computers in copy rooms.
D. Receptacles on circuits rated more than 20 amperes.
E. Receptacles connected to an uninterruptible power supply (UPS) that are intended to be in continuous use, 24 hours per day/365 days per year, and are marked to differentiate them from other uncontrolled receptacles or circuits.

Exception 2 to Section 160.6(d): Receptacles in common use areas providing shared provisions for living, eating, cooking or sanitation to dwelling units that would otherwise lack these provisions.

(e) **Demand responsive controls and equipment.** See Section 110.12 for requirements for demand responsive controls and equipment, including demand responsive controls for controlled receptacles.

NOTE: Definitions of terms and phrases in Section 160.6 are determined as specified in Section 100.1(b). Terms and phrases not found in Section 100.1(b) shall be defined as specified in Title 24, Part 3, Article 100 of the *California Electrical Code*.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.7—MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(a) **Elevators.** Elevators shall meet the requirements of Section 120.6(f).

(b) **Pool and spa systems.** Pool and spa systems available to multiple tenants or to the public shall comply with the applicable requirements of Section 110.4. Pool and spa systems installed for exclusive use by a single tenant shall comply with the applicable requirements of Section 150.0(p). Pool and spa systems installed for public use shall comply with Section 150.0(p)2, Section 150.0(p)3, and Section 150.0(p)4.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 160.8—MANDATORY REQUIREMENTS FOR SOLAR READY BUILDINGS

(a) **Solar ready buildings.** Newly constructed multifamily buildings shall meet the requirements of Section 110.10 applicable to the building project.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, *Public Resources Code.*

SECTION 160.9—MANDATORY REQUIREMENTS FOR ELECTRIC READY BUILDINGS

(a) **General requirements.** Multifamily buildings shall comply with the applicable requirements of Subsection 160.9. The building electrical system shall be sized to meet the future electric requirements of the electric ready equipment specified in Sections 160.9(b) through (f). The building main service conduit, the electrical system to the point specified in each subsection, and any on-site distribution transformers shall have sufficient capacity to supply full-rated amperage at each electric ready appliance in accordance with the *California Electrical Code.*

(b) **Heat pump space heater ready.** Systems using gas or propane furnaces to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the furnace and accessible to the furnace with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future heat pump space heater installation. The reserved space shall be permanently marked as "For Future 240V use."

(c) **Electric Cooktop Ready.** Systems using gas or propane cooktops to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the cooktop and accessible to the cooktop with no obstructions. The branch circuit conductors shall be rated at 50 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric cooktop installation. The reserved space shall be permanently marked as "For Future 240V use."

(d) **Electric Clothes Dryer Ready.** Clothes dryer locations with gas or propane plumbing shall include the following:

1. Systems serving individual dwelling units shall include:
   A. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the clothes dryer location and accessible to the clothes dryer location with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready." All electrical components shall be installed in accordance with the *California Electrical Code*.
   B. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric clothes dryer installation. The reserved space shall be permanently marked as "For Future 240V use."
2. Systems in common use areas shall include:
   A. Conductors or raceway shall be installed with termination points at the main electrical panel, via subpanels panels if applicable, to a location no more than 3 feet from each gas outlet or a designated location of future electric replacement equipment. Both ends of the conductors or raceway shall be labelled "Future 240V Use." Gas flow rates shall be determined in accordance with the *California Plumbing Code*. Capacity shall be one of the following:
      i. 24 amps at 208/240 volts per clothes dryer;
      ii. 2.6 kVA for each 10,000 Btu per hour of rated gas input or gas pipe capacity; or
      iii. The electrical power required to provide equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

(e) **Individual Heat Pump Water Heater Ready.** Systems using gas or propane water heaters to serve individual dwelling units shall include the following components for each gas or propane water heater:

1. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor branch circuit rated to 30 amps minimum, within 3 feet from the water heater and accessible to the water heater with no obstructions. In addition, all the following:
   A. Both ends of the unused conductor shall be labeled with the word "spare" and be electrically isolated; and
   B. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in Item A and labeled with the words "Future 240V Use"; and
2. A condensate drain that is no more than 2 inches higher than the base of the installed water heater and allows natural draining without pump assistance; and
3. The construction drawings shall designate a space at least 39 inches by 39 inches and 96 inches tall for the future location of a heat pump water heater (HPWH).
4. A ventilation method meeting one of the following:
   A. The designated space for the future heat pump water heater shall have a minimum volume of 700 cubic feet; or
   B. If the future HPWH space is designed to vent indoors, the designated space for the future heat pump water heater shall vent to a communicating space in the same pressure boundary. The total combined volume connected shall be 700 cubic feet or larger and vent to the interior via:
      i. Fully louvered doors with fixed louvers consisting of a single layer of fixed flat slats and a minimum total net free area (NFA) of 250 square inches; or
      ii. Two permanent openings of equal area with a minimum total NFA of 250 square inches located within 12 inches from the enclosure top and bottom; or
      iii. Two 8-inch ducts to a communicating space.
   C. If the future HPWH space is designed to vent to the building exterior, the designated space for the future heat pump water heater shall vent to the exterior via:
      i. Fully louvered doors with fixed louvers consisting of a single layer of fixed flat slats and a minimum total NFA of 250 square inches; or
      ii. Two permanent openings of equal area with a minimum total NFA of 250 square inches located within 12 inches from the enclosure top and bottom; or
      iii. Two 8 -inch capped ducts. All ducts that cross the pressure boundary shall be insulated to a minimum insulation level of R-6 and the ducts, connections, and building penetrations shall be sealed.

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(f) **Central Heat Pump Water Heater Ready.** Central water heating systems using gas or propane to serve multiple dwelling units shall meet the following requirements:

1. The system input capacity of the gas or propane water heating system shall be determined as the sum of the input gas or propane capacity of all water heating devices associated with each gas or propane water heating system.
2. Space reserved shall include:
   A. Heat pump. The minimum space reserved shall include space for service clearances and airflow clearances and shall meet one of the following:
      i. The space reserved shall be the space required for a HPWH system that meets the total building hot water demand as calculated and documented by the responsible person associated with the project; or
      ii. The space reserved shall meet the requirements specified in Joint Appendix JA15.2.1.
   B. Tanks. The minimum space reserved shall include space for service clearances and shall meet one of the following:
      i. The space reserved shall be the space required for a HPWH system that meets the total building hot water demand as calculated and documented by the responsible person associated with the project; or
      ii. The space reserved shall meet the requirements specified in Joint Appendix JA15.2.2.
3. Ventilation shall be provided by meeting one of the following:
   A. Physical space reserved for the heat pump shall be located outside; or
   B. A pathway shall be reserved for future routing of supply and exhaust air via ductwork from the reserved heat pump location to a suitable outdoor location. Penetrations through the building envelope for louvers and ducts shall be planned and identified for future use. The reserved pathway and penetrations through the building envelope shall be sized to meet one of the following:
      i. The reserved pathway and penetrations shall be sized to serve a HPWH system that meets the total building hot water demand as calculated and documented by the responsible person associated with the project.
      ii. The reserved pathway and penetrations shall be sized to meet the requirements specified in Joint Appendix JA15.2.3.
4. Condensate drainage piping. An approved receptacle that is sized per the *California Plumbing Code* for condensate drainage shall be installed within 3 feet of the reserved heat pump location, or piping shall be installed from within 3 feet of the reserved heat pump location to an approved discharge location that is sized in accordance with the *California Plumbing Code*, and meet one of the following:
   i. Condensate drainage shall be sized to serve a HPWH system that meets the total building hot water demand as calculated and documented by the responsible person associated with the project.
   ii. Condensate drainage piping shall be sized to meet the requirements specified in Joint Appendix JA15.2.4.
5. Electrical.
   A. Physical space shall be reserved on the bus system of the main switchboard or on the bus system of a distribution board to serve the future HPWH system, including the heat pump and temperature maintenance tanks. In addition, the physical space reserved shall be capable of providing adequate power to the future heat pump water heater in accordance with the following:
      i. Heat pump. Meet one of the following:
         A. The electrical power required to power a HPWH system that meets the total building hot water demand as calculated and documented by the responsible person associated with the project.
         B. The electrical power required that meets the requirements specified for the heat pump in Joint Appendix JA15.2.5.
      ii. Temperature maintenance tank. Meet one of the following:
         A. The electrical power required to power a HPWH system temperature maintenance tank that meets the total building hot water demand as calculated and documented by the responsible person associated with the project.
         B. The electrical power required that meets the requirements specified for the temperature maintenance tank in Joint Appendix JA15.2.5.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SUBCHAPTER

11

MULTIFAMILY BUILDINGS—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 170.0—GENERAL

Multifamily buildings shall comply with the applicable requirements of Sections 170.0 through 170.2. Sections 170.0 through 170.2 apply to dwelling units and common use areas in multifamily buildings. Nonresidential occupancies in mixed occupancy buildings shall comply with nonresidential requirements in Sections 120, 130, 140 and 141.

(a) Multifamily buildings shall meet all of the following:

1. The applicable requirements of Sections 110.0 through 110.10.
2. The applicable requirements of Section 160.0 (mandatory features).
3. Either the performance standards Section 170.1 or the prescriptive standards Section 170.2 set forth in this subchapter for the climate zone in which the building is located. Climate zones are shown in Reference Joint Appendix JA2—Weather/Climate Data.

Exception to Section 170.0 (a)3: If a single development falls in more than one climate zone, all buildings in the subdivision or tract may be designed to meet the performance or prescriptive standards for the climate zone that contains 50 percent or more of the dwelling units.

NOTE: The Commission periodically updates, publishes and makes available to interested persons and local enforcement agencies precise descriptions of the climate zones, as specified in Reference Joint Appendix JA2—Weather/Climate Data.

NOTE: The requirements of Sections 170.1(a) through 170.2(e) apply to newly constructed buildings and Sections 180.1 and 180.2 specify changes to the requirements of Sections 170.1(a) through 170.2(e) that apply to additions or alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 170.1—PERFORMANCE APPROACH

A building complies with the performance approach if the energy consumption calculated for the proposed design building is no greater than the energy budget calculated for the standard design building using Commission-certified compliance software as specified by Sections 10-109 and 10-116 and the Alternative Calculation Method Reference Manual.

(a) **Energy budget.** The energy budget is expressed in terms of long-term system cost (LSC) and source energy:

1. **Long-term system cost (LSC).** The LSC energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building and has two components, the Efficiency LSC and the Total LSC.
   A. The Efficiency LSC energy is the sum of the LSC energy for space-conditioning, water heating, mechanical ventilation, lighting and the self-utilization credit.
   B. The Total LSC energy is the sum of the Efficiency LSC energy and LSC energy from the photovoltaic system, battery energy storage systems (BESS), and demand flexibility.
2. **Source energy.** The source energy budget is determined by applying the mandatory and prescriptive requirements of the standard design, except with a consumer gas or propane water heater, to the proposed design building.

Exception to Section 170.1(a): A community shared solar electric generation system, or other renewable electric generation system, and/or community shared BESS, that provides dedicated power, utility energy reduction credits or payments for energy bill reductions to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system or BESS LSC energy required to comply with the standards, as calculated according to methods established by the Commission in the Nonresidential ACM Reference Manual.

(b) **Compliance demonstration requirements for performance standards.**

1. Certificate of Compliance and Application for a Building Permit. The application for a building permit shall include documentation pursuant to Sections 10-103(a)1 and 10-103(a)2 that demonstrates, using an approved calculation method, that the building has been designed so that its source energy and LSC energy consumption do not exceed the standard design energy budgets for the applicable climate zone.
2. Field verification of individual dwelling unit systems. When performance of installed features, materials, components, manufactured devices or systems above the minimum specified in Section 170.2 is necessary for the building to comply with Section 170.1, or is necessary to achieve a more stringent local ordinance, field verification shall be performed in accordance with the applicable requirements in the following subsections, and the results of the verification(s) shall be documented on applicable Certificates of Installation pursuant to Section 10-103(a)3 and applicable Certificates of Verification pursuant to Section 10-103(a)5.
   A. EER2/SEER2/CEER/HSPF2 Rating. When performance compliance requires installation of a space-conditioning system with a rating that is greater than the minimum rating required by Table 170.2-K or specified for the standard

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design, the installed system shall be field verified in accordance with the procedures specified in the applicable sections of Reference Residential Appendix RA3.

B. Variable capacity heat pump (VCHP) compliance option. When performance compliance requires installation of a heat pump system that meets all the requirements of the VCHP compliance option specified in the ACM Reference Manual, the system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.4.3.

C. Low leakage air handler. When performance compliance requires installation of a low leakage air-handling unit, the installed air handling unit shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9.

D. Thermal balancing valve. When performance compliance requires installation of thermal balancing valves with variable speed circulation pump(s), the installation shall meet the procedures specified in Reference Residential Appendix RA4.4.3.

E. Heat pump—rated heating capacity. When performance compliance requires installation of a heat pump system, the heating capacity values at 47°F and 17°F shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.2.

F. Dwelling unit enclosure air leakage. When performance compliance requires a building enclosure leakage rate that is lower than the standard design, the building enclosure shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.8.

G. Quality insulation installation (QII). When performance compliance requires field verification of QII, the building insulation system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.5.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 170.2—PRESCRIPTIVE APPROACH

Multifamily buildings, including both dwelling units and common use areas, that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements for the appropriate climate zone shown in Table 170.2-A. In Table 170.2-A, NA (not allowed) means that feature is not permitted in a particular climate zone and NR (no requirement) means that there is no prescriptive requirement for that feature in a particular climate zone. Installed components shall meet the following requirements:

(a) **Envelope component requirements**.

1. **Exterior roofs and ceilings**. Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

   A. Roofing products. All roofing products shall meet the requirements of Section 110.8 and the applicable minimum aged solar reflectance and thermal emittance requirements of Table 170.2-A.

   Exception 1 to Section 170.2(a)1A: Roof area covered with building integrated photovoltaic panels and building integrated solar thermal panels are not required to comply with the minimum requirements for solar reflectance and thermal emittance or SRI.

   Exception 2 to Section 170.2(a)1A: Roof constructions with a weight of at least 25 lb/ft^2 are not required to comply with the minimum requirements for solar reflectance and thermal emittance or SRI.

   B. Roof insulation. roofs shall have an overall assembly *U*-factor no greater than the applicable value in Table 170.2-A, meeting i, ii, iii or iv below. Where required by Sections 110.8 and 160.1(a), insulation shall be placed in direct contact with a continuous roof or drywall ceiling.

      i. Option A: Reserved.

      ii. Option B: A minimum *R*-value of insulation installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 170.2(c)3Biia; or

      iii. Option C: A minimum *R*-value of ceiling insulation located between the attic and the conditioned space when meeting Section 170.2(c)3Biib.

      iv. Option D: A minimum *U*-factor for roof assemblies above conditioned space without attic space.

   C. Radiant barrier. A radiant barrier required in Table 170.2-A shall meet the requirements specified in Section 110.8(j), and shall meet the installation criteria specified in Reference Residential Appendix RA4**.**

2. **Wall insulation.**

   A. Exterior walls shall have an overall assembly *U*-factor no greater than the applicable value in Table 170.2-A.

   B. Demising walls shall meet the requirements of Section 160.1(b)7. Vertical windows in demising walls between conditioned and unconditioned spaces shall have an area-weighted average *U*-factor no greater than the applicable value in Table 170.2-A.

3. **Fenestration.**

   A. Vertical fenestration and glazed doors in exterior walls shall comply with Subsections i, ii and iii:

i. Percent fenestration area shall be limited in accordance with the applicable requirements of a and b below:

a. A total fenestration area no greater than 20 percent of the conditioned floor area; and

b. A total fenestration area no greater than 40 percent of the gross exterior wall area.

NOTE: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area, and fenestration in demising walls is not part of the fenestration area limitation.

ii. Fenestration properties. Installed fenestration products, including glazed doors, shall have an area-weighted average *U*-factor, relative solar heat gain coefficient (RSHGC) and visible transmittance (VT) meeting the applicable fenestration values in Table 170.2-A and shall be determined in accordance with Sections 110.6(a)2 and 110.6(a)3.

Vertical fenestration in demising walls between conditioned and unconditioned spaces is only required to comply with the area-weighted average *U*-factor requirement in Table 170.2-A.

Exception 1 to Section 170.2(a)3Aii: For each dwelling unit, up to 3 square feet of new glazing area installed in doors shall not be required to meet the *U*-factor and RSHGC requirements of Table 170.2-A.

Exception 2 to Section 170.2(a)3Aii: For fenestration containing chromogenic type glazing:

a. The lower-rated labeled *U*-factor and SHGC shall be used with automatic controls to modulate the amount of solar gain and light transmitted into the space in multiple steps in response to daylight levels or solar intensity;

b. Chromogenic glazing shall be considered separately from other fenestration; and

c. Area-weighted averaging with other fenestration that is not chromatic shall not be permitted and shall be determined in accordance with Section 110.6(a).

Exception 3 to Section 170.2(a)3Aii: For dwelling units containing unrated site-built fenestration that meets the maximum area restriction, the *U*-factor and SHGC can be determined in accordance with Nonresidential Reference Appendix NA6 or using default values in Table 110.6-A and Table 110.6-B.

Exception 4 to Section 170.2(a)3Aii: Fenestration in dwelling units of buildings in Climate Zones 1, 3, 5 and 16 is not required to comply with the RSHGC requirements.

Exception 5 to Section 170.2(a)3Aii: Fenestration in dwelling units is not required to comply with the VT requirements.

iii. Shading. Where Table 170.2-A requires a maximum RSHGC, the requirements shall be met with an area-weighted average RSHGC excluding the effects of interior shading, no greater than the applicable value in Table 170.2-A.

For the purposes of this paragraph, the RSHGC of a vertical window is:

a. The solar heat gain coefficient of the window; or

b. Relative solar heat gain coefficient is calculated using Equation 170.2-A, if the window has an overhang that extends beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

Exception 1 to Section 170.2(a)3Aiiib: An area-weighted average relative solar heat gain coefficient of 0.56 or less shall be used for windows:

I. That are in the first story of exterior walls that form a display perimeter; and

II. For which codes restrict the use of overhangs to shade the windows.

Exception 2 to Section 170.2(a)3Aiiib: For vertical glazing containing chromogenic type glazing:

I. the lower-rate labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

II. chromogenic glazing shall be considered separately from other glazing; and

III. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

NOTE: Demising walls are not exterior walls, and therefore fenestration in demising walls is not subject to SHGC requirements.

(Equation 170.2-A) $RSHGC = SHGC \times [1 + a \times (2.72^{-PF} - 1) \times (\sin(b \times Az) + c)]$

where:

COMPONENT	a	b	c
Overhang	0.150	0.008727	5.67
Exterior Horizontal Slat	0.144	0.008727	5.13

RSHGC = Relative solar heat gain coefficient.

SHGC = Solar heat gain coefficient of the vertical fenestration.

Az = Azimuth of the vertical fenestration in degrees.

PF = Projection factor as calculated by Equation 140.3-C.

iv. Vertical fenestration shall have an area-weighted average visible transmittance (VT) no less than the applicable value in Table 170.2-A, or Equation 170.2-B, as applicable.

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Exception 1 to Section 170.2(a)3Aiv: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 170.2(a)3Aivw.

Exception 2 to Section 170.2(a)3Aiv: If the window's VT is not within the scope of NFRC 200 or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

Exception 3 to Section 170.2(a)3Aiv: For vertical windows containing chromogenic type glazing:

a. The higher rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity;
b. Chromogenic glazing shall be considered separately from other glazing; and
c. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

> **Exception 4 to Section 170.2(a)3Aiv:** Fenestration in dwelling units is not required to comply with the VT requirements.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

(Equation 170.2-B) $VT \geq 0.11/WWR$

where:

WWR = Window Wall Ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in Equation 170.2-B.

VT = Visible transmittance of framed window.

B. **Skylights shall:**

i. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

Exception 1 to Section 170.2(a)3Bi: Buildings with an atrium over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

ii. Have an area-weighted performance rating *U*-factor no greater than the applicable value in Table 170.2-A.

Exception 2 to Section 170.2(a)3Bii: For each dwelling unit up to 16 square feet of new skylight area with a maximum U-factor of 0.55 and a maximum SHGC of 0.30.

iii. Solar heat gain coefficient. Have an area-weighted performance rating solar heat gain coefficient no greater than the applicable value in Table 170.2-A.

Exception to Sections 170.2(a)3Bii and 170.2(a)3Biii: For skylights containing chromogenic type glazing:

a. The lower-rated labeled SHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and
b. Chromogenic glazing shall be considered separately from other glazing; and
c. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

iv. Haze value. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003 or other test method approved by the Energy Commission.

Exception to Section 170.2(a)3Biv: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

4. All exterior doors, excluding glazed doors, that separate conditioned space from unconditioned space or from ambient air shall have a *U*-factor not greater than the applicable value in Table 170.2-A. Glazed doors must comply with the requirements of Section 170.2(a)3A.

Exception to Section 170.2(a)4: Swinging doors that are required to have fire protection are not required to meet the applicable door value in Table 170.2-A.

5. Floors shall meet the following requirements:

A. Raised floors shall be insulated such that the floor assembly has an assembly *U*-factor equal to or less than shown in Table 170.2-A, or shall be insulated between wood framing with insulation having an *R*-value equal to or greater than shown in Table 170.2-A.

|| B. Slab floors shall have perimeter insulation installed with a *U*-factor equal to or less than or *R*-value equal to or greater than shown in Table 170.2-A. The minimum depth of concrete slab floor perimeter insulation shall be 16 inches or the depth of the footing of the building, whichever is less.

Exception to Section 170.2(a)5: Raised-floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in Table 170.2-A.

6. All buildings up to three habitable stories shall comply with the quality insulation installation (QII) requirements shown in Table 170.2-A. When QII is required, insulation installation shall meet the criteria specified in Reference Appendix RA3.5.

Exception to Section 170.2(a): The insulation requirements of Table 170.2-A and Table 170.2-B may be met by ceiling, roof deck, wall or floor assemblies that meet the required maximum *U*-factors using a *U*-factor calculation method that considers the thermal effects of all elements of the assembly and is approved by the Executive Director.

TABLE 170.2-A—ENVELOPE COMPONENT PACKAGE-MULTIFAMILY STANDARD BUILDING DESIGN

BUILDING COMPONENT - ROOFS AND CEILINGS	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Option B[9] Below Roof Deck Insulation[1,2] (with air space)	NR	NR	NR	R19	NR	NR	NR	R19	R19	R13	R19	R19	R19	R19	R19	R13
Option B[9] Ceiling Insulation	R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
Option B[9] Radiant Barrier	NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
Option B[9] Low-Sloped Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
Option B[9] Low-Sloped Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
Option B[9] Low-Sloped Solar Reflectance Index	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
Option B[9] Steep-Sloped Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.25	0.25	0.20	0.25	0.20	0.25	NR
Option B[9] Steep-Sloped Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
Option B[9] Steep-Sloped Solar Reflectance Index	NR	NR	NR	NR	NR	NR	NR	NR	NR	23	23	16	23	16	23	NR
Option C[10] Ceiling Insulation	R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
Option C[10] Radiant Barrier	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Option C[10] Low-Sloped Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
Option C[10] Low-Sloped Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
Option C[10] Low-Sloped Solar Reflectance Index	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
Option C[10] Steep-Sloped Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
Option C[10] Steep-Sloped Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR
Option C[10] Steep-Sloped Solar Reflectance Index	NR	NR	NR	NR	NR	NR	NR	NR	NR	16	16	16	16	16	16	NR
Option D[11] Metal Building U-factor	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
Option D[11] Wood Framed and Other U-factor	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Option D[11] Low-Sloped Aged Solar Reflectance	NR	0.63	NR	0.63	NR	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	NR
Option D[11] Low-Sloped Thermal Emittance	NR	0.75	NR	0.75	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	NR
Option D[11] Low-Sloped Solar Reflectance Index	NR	75	NR	75	NR	75	75	75	75	75	75	75	75	75	75	NR
Option D[11] Steep-Sloped Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
Option D[11] Steep-Sloped Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	NR
Option D Steep-Sloped Solar Reflectance Index	NR	16	16	16	16	16	16	16	16	16	16	16	16	16	16	NR
BUILDING COMPONENT - WALLS, FLOORS, DOORS AND QII	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Walls - Metal Building - Any Fire Rating	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
Walls - Framed (wood, metal) and other - > 1-hr fire rating	0.059	0.059	0.059	0.059	0.059	0.065	0.065	0.059	0.059	0.059	0.051	0.059	0.059	0.051	0.051	0.051
Walls - Framed (wood, metal) and other - ≤ 1-hr fire rating[3]	0.051	0.051	0.051	0.051	0.051	0.065	0.065	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Walls - Mass Light[4]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.059 R 17
Walls - Mass Heavy	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
Floors/Soffits - Slab Perimeter[8]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	F 0.58 R 7.0
Floors/Soffits – Wood Framed	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19

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TABLE 170.2-A—ENVELOPE COMPONENT PACKAGE – MULTIFAMILY STANDARD BUILDING DESIGN—continued

BUILDING COMPONENT - WALLS, FLOORS, DOORS AND QII	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Floors/Soffits – Wood Framed	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19
Floors/Soffits - Raised Mass	U 0.092 R 8.0	U 0.092 R 8.0	U 0.269 R 0	U 0.269 R 0	U-0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0
Floors/Soffits - Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
Exterior Doors[6] - Max U-Factor Dwelling Unit Entry	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Exterior Doors[6] - Max U-Factor Common-Use Area Entry Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
Exterior Doors[6] - Max U-Factor Common-Use Area Entry Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Quality Insulation Installation up to 3 Habitable Stories	Yes	Yes	Yes	Yes	Yes	Yes	NR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BUILDING COMPONENT - FENESTRATION	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Curtain Wall/ Storefront[7] - Maximum U-Factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
Curtain Wall/ Storefront[7] - Maximum RSHGC	NR	0.26	NR	0.26	NR	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	NR
Curtain Wall/ Storefront[7] - Minimum VT, Common-Use Area	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
NAFS 2017 Performance Class AW[5] - Maximum U-Factor	0.38	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.38
NAFS 2017 Performance Class AW[5] - Maximum RSHGC	NR	0.24	NR	0.24	NR	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR
NAFS 2017 Performance Class AW[5] - Minimum VT, Common-Use Areas	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
All Other Fenestration - Maximum U-Factor	0.28	0.30	0.28	0.28	0.28	0.34	0.34	0.30	0.30	0.30	0.28	0.30	0.28	0.28	0.28	0.28
All Other Fenestration - Maximum RSHGC	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
Maximum Window to Floor Ratio	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Maximum Window to Wall Ratio	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Maximum Skylight Roof Ratio	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

1. Install the specified *R*-value with an airspace present between the roofing and the roof deck. Such as standard installation of concrete or clay tile.
2. *R*-values shown for below roof deck insulation are for wood-frame construction with insulation installed between the framing members. Alternatives including insulation above rafters or above roof deck shall comply with the performance standards.
3. Assembly *U*-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly *U*-factor equal to or less than the *U*-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to be less than or equal to the required maximum U-factor.
4. Mass wall has a heat capacity greater than or equal to 7.0 Btu/h-ft^2.
5. Product must be certified to meet the North American Fenestration Standard/Specification for an Architectural Window (AW).
6. Glazed doors must meet the fenestration requirements.
7. Requirements apply to doors included in the curtain wall/storefront construction assembly.
8. If using *F*-factor to comply, use Reference Joint Appendices JA4, Table 4.4.7 to determine alternate depth and R-value to be less than or equal to the required maximum *F*-factor.
9. Option B meets §170.2(a)1Bii.
10. Option C meets §170.2(a)1BIiii.
11. Option D meets §170.2(a)1Biv.

TABLE 170.2-B—SUPPLY FAN POWER ALLOWANCES (watts/cfm)

	MULTI-ZONE VAV SYSTEMS ≤ 5,000 cfm	MULTI-ZONE VAV SYSTEMS > 5,000 and ≤ 10,000 cfm	MULTI-ZONE VAV SYSTEMS > 10,000 cfm	ALL OTHER FAN SYSTEMS ≤ 5,000 cfm	ALL OTHER FAN SYSTEMS > 5,000 and ≤ 10,000 cfm	ALL OTHER FAN SYSTEMS > 10,000 cfm
Supply System Base Allowance for AHU Serving Spaces < 6 Floors Away	0.395	0.453	0.413	0.232	0.256	0.236
Supply System Base Allowance for AHU Serving Spaces > 6 Floors Away	0.508	0.548	0.501	0.349	0.356	0.325
MERV 13 to MERV 16 Filter Upstream of Thermal Conditioning Equipment (two times the clean filter pressure drop)[2]	0.136	0.114	0.105	0.139	0.120	0.107
MERV 13 to MERV 16 Final Filter Downstream of Thermal Conditioning Equipment (two times the clean filter pressure drop)[2]	0.225	0.188	0.176	0.231	0.197	0.177
Filtration Allowance for > MERV 16 or HEPA Filter (two times the clean filter pressure drop)[2]	0.335	0.280	0.265	0.342	0.292	0.264
Central Hydronic Heating Coil Allowance	0.046	0.048	0.052	0.046	0.050	0.054
Electric Heat Allowance	0.046	0.038	0.035	0.046	0.040	0.036
Gas Heat Allowance	0.069	0.057	0.070	0.058	0.060	0.072
Hydronic/DX Cooling Coil, or Heat Pump Coil (wet) Allowance	0.135	0.114	0.105	0.139	0.120	0.107
Solid or Liquid Desiccant System Allowance	0.157	0.132	0.123	0.163	0.139	0.124
Reheat Coil for Dehumidification Allowance	0.045	0.038	0.035	0.046	0.040	0.036
Allowance for evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed watts/cfm per 1.0 in. wg. Determine pressure loss (in. wg) at 400 fpm or maximum velocity allowed by the manufacturer, whichever is less. *[Calculation required, see note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Allowance for 100% outdoor air system meeting the requirements of Note 5.	0.000	0.000	0.000	0.070	0.100	0.107
Energy Recovery Allowance for 0.50 ≤ ERR < 0.55[6]	0.135	0.114	0.105	0.139	0.120	0.107
Energy Recovery Allowance for 0.55 ≤ ERR < 0.60[6]	0.160	0.134	0.124	0.165	0.141	0.126
Energy Recovery Allowance for 0.60 ≤ ERR < 0.65[6]	0.184	0.155	0.144	0.190	0.163	0.146
Energy Recovery Allowance for 0.65 ≤ ERR < 0.70[6]	0.208	0.175	0.163	0.215	0.184	0.165
Energy Recovery Allowance for 0.70 ≤ ERR < 0.75[6]	0.232	0.196	0.183	0.240	0.205	0.184
Energy Recovery Allowance for 0.75 ≤ ERR < 0.80[6]	0.257	0.216	0.202	0.264	0.226	0.203
Energy Recovery Allowance for ERR ≥ 0.80[6]	0.281	0.236	0.222	0.289	0.247	0.222
Coil Runaround Loop	0.135	0.114	0.105	0.139	0.120	0.107
Allowance for gas phase filtration required by code or accredited standard. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop. *[Calculation required, see note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Economizer Return Damper	0.045	0.038	0.035	0.046	0.040	0.036
Air Blender Allowance	0.045	0.038	0.035	0.046	0.040	0.036
Allowance for sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.034	0.029	0.026	0.035	0.030	0.027
Deduction for systems that feed a terminal unit with a fan with electrical input power < 1kW	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100
Low-turndown single-zone VAV fan systems meeting the requirements in Note 7	0.000	0.000	0.000	0.070	0.100	0.089

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) in definition a multi-zone VAV system.
2. Filter fan power allowance can only be counted once per fan system.
3. Reserved.
4. Power allowance requires further calculation by multiplying the actual in. wg of the device/component by the watts/cfm in Table 170.2-B.
5. The 100 percent outdoor air system must serve three or more HVAC zones and airflow during noneconomizer operating periods must not exceed 135 percent of minimum requirements in Section 120.1(c)(3).
6. Energy recovery ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
7. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.

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(b) **Minimum daylighting requirement for large enclosed spaces.** In Climate Zones 2 through 15, conditioned enclosed spaces and unconditioned enclosed spaces that are greater than 5,000 ft^2 and that are directly under a roof with ceiling heights greater than 15 feet shall meet the following requirements:

1. A combined total of at least 75 percent of the floor area, as determined in building floor plan (drawings) view, shall be within one or more of the following:
   A. Primary sidelight daylight zone in accordance with Section 160.5(b)4Dib, or
   B. The total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.
2. All skylit daylit zones and primary sidelit daylit zones shall be shown on building plans.
3. General lighting in daylit zones shall be controlled in accordance with Section 160.5(b)4D.
4. The total skylight area is at least 3 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights; or the product of the total skylight area and the average skylight visible transmittance is no less than 1.5 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.
5. All skylights shall have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D1003 (notwithstanding its scope) or another test method approved by the Commission.

   Exception 1 to Section 170.2(b): In buildings with unfinished interiors, future enclosed spaces for which there are plans to have:
   A. A floor area of less than or equal to 5,000 square feet; or
   B. Ceiling heights of less than or equal to 15 feet. This exception shall not be used for S-1 or S-2 (storage), or for F-1 or F-2 (factory) occupancies.

   Exception 2 to Section 170.2(b): Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 watts per square foot.

   Exception 3 to Section 170.2(b): Enclosed spaces where it is documented that permanent architectural features of the building, existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

(c) **Space-conditioning systems.** All space heating, space cooling and ventilation equipment shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and the applicable requirements of Subsections 1 through 4.

1. Sizing and equipment selection—common use areas. Mechanical heating and mechanical cooling equipment serving common use areas of multifamily buildings shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection 2 below.

   Exception 1 to Section 170.2(c)1: Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building LSC energy use.

   Exception 2 to Section 170.2(c)1: Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

   Exception 3 to Section 170.2(c)1: Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.
2. Calculations—common use areas. In making equipment sizing calculations under Subsection (c)1, all of the following rules shall apply:
   A. Heating and cooling loads. Heating and cooling system design loads shall be determined in accordance with the method in the 2021 ASHRAE Handbook, Fundamentals Volume, or as specified in a method approved by the Commission.
   B. Indoor design conditions. Indoor design temperature and humidity conditions for comfort applications shall be determined using ASHRAE Standard 55 or the 2021 ASHRAE Handbook, Fundamentals Volume, except that winter humidification and summer dehumidification shall not be required.
   C. Outdoor design conditions. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X or the ASHRAE Handbook, Fundamentals Volume. Heating design temperatures shall be no lower than the 99.0 percent Heating Dry Bulb or the Heating Winter Median of Extremes values. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

      Exception to Section 170.2(c)2C: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent Cooling Design Wet Bulb values.
   D. Ventilation. Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 160.2(c)3.
   E. Envelope. Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, solar heat gain coefficient or shading coefficient, and air leakage, consistent with the proposed design.

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F. Lighting. Lighting heating and cooling loads shall be based on actual design lighting levels or power densities as specified in Section 170.2(e)1.

G. People. Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 160.2(c)3A, if used. Sensible and latent heat gains shall be as listed in the 2017 ASHRAE Handbook—Fundamentals, Chapter 18.

H. Process loads. Loads caused by a process shall be based upon actual information on the intended use of the building.

I. Miscellaneous equipment. Equipment loads other than process loads shall be calculated using design data compiled from one or more of the following sources:

i. Actual information based on the intended use of the building; or

ii. Published data from manufacturers' technical publications or from technical societies, such as the ASHRAE Handbook, Applications Volume; or

iii. Other data based on the designer's experience of expected loads and occupancy patterns.

J. Internal heat gains. Internal heat gains may be ignored for heating load calculations.

K. Safety factor. Calculated design loads based on Sections 170.2(c)2A through K may be increased by up to 10 percent to account for unexpected loads or changes in space usage.

L. Other loads. Loads such as warm-up or cool-down shall be calculated from principles based on the thermal capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. In addition, the steady-state load may include a safety factor in accordance with Section 170.2(c)2K.

3. Dwelling unit space-conditioning systems.

A. Heating system type. Space-conditioning systems serving dwelling units shall meet i or ii. Systems that cannot meet the requirements of i or ii, including multi-zone systems and systems using central boilers or chillers, shall comply with the performance requirements of Section 170.1.

i. Multifamily buildings three habitable stories or fewer. For Climate Zones 1 through 15, the space-conditioning system shall be a heat pump. For Climate Zone 16, the space-conditioning system shall be an air conditioner with furnace. Additionally, balanced ventilation systems serving these dwelling units shall meet the applicable requirements of Section 170.2(c)3Bivc.

ii. Multifamily buildings four habitable stories or greater. For Climate Zones 2 through 15, the space-conditioning system shall be a heat pump. For Climate Zones 1 and 16, the space-conditioning system shall be a dual-fuel heat pump.

Exception to Section 170.2(c)3A: A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kW or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

B. Space-conditioning and ventilation systems. All space heating and space cooling equipment serving dwelling units shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and meet all applicable requirements of Sections 160.3(b) and 170.2(c)2.

i. Refrigerant charge—systems serving individual dwelling units. When refrigerant charge verification or fault indicator display is shown as required by Table 170.2-K, the system shall comply with either Section 170.2(c), 170.2(c)3Bia or 170.2(c)3Bib:

a. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems and mini-split systems, shall comply with Subsections I, II and III, unless the system is of a type that cannot be verified using the specified procedures:

I. Have measurement access holes (MAH) installed according to the specifications in Reference Residential Appendix Section RA3.2.2.3; and

II. System airflow rate in accordance with Subsection A or B below shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix Section RA3.3 or an approved alternative procedure as specified by RA1; and

A. For small duct high velocity systems, the system airflow rate shall be greater than or equal to 250 cfm per ton; or

B. For all other air-cooled air conditioner or air-source heat pump systems, the system airflow rate shall be greater than or equal to 350 cfm per ton.

III. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable:

A. The installer and rater shall perform the standard charge procedure as specified by Reference Residential Appendix Section RA3.2.2 or an approved alternative procedure as specified by RA1; or

B. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1, provided the system is of a type that can be verified using

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the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate verification procedure or approved alternatives in RA1. The ECC-Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1.

Exception to Section 170.2(c)3BiaI: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.2-1 shall not be required to provide holes as described in Figure RA3.2-1.

Exception to Section 170.2(c)3BiaII: Standard ducted systems without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in Table 160.3-A and Table 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 160.2(b)1D for the system air filter device(s) shall conform to the requirements given in Table 160.3-A and Table 160.3-B.

Exception to Section 170.2(c)3BiaIII: When the outdoor temperature is less than 55°F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to verify the refrigerant charge, the installer may elect to utilize the verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirement in Section 170.2(c)3BiaII.

b. For air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems and mini-split systems, which are of a type that cannot comply with the requirements of Section 170.2(c)3Bi:

I. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix Section RA3.2.3.1, as verified by a ECC-Rater according to the procedures specified in Reference Residential Appendix Section RA3.2.3.2; and

II. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 170.2(c)3BiaII, provided the system is of a type that can be verified using the procedures in RA3.3 or an approved alternative procedure in RA1.

Exception 1 to Section 170.2(c)3Bi: Packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify that the packaged system was precharged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 170.2(c)3Bib, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

Exception 2 to Section 170.2(c)3Bi: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

ii. Space-conditioning distribution systems. All space-conditioning systems shall meet all applicable requirements of a or b below:

a. High performance attics. Air handlers or ducts are allowed to be in ventilated attic spaces when the roof and ceiling insulation level meet Option B in Table 170.2-A.

b. Duct and air handlers located in conditioned space. Duct systems and air handlers of HVAC systems shall be located in conditioned space, and confirmed by field verification and diagnostic testing to meet the criterion of Reference Residential Appendix RA3.1.4.3.8.

NOTE: Gas heating appliances installed in conditioned spaces must meet the combustion air requirements of *California Mechanical Code* Chapter 7, as applicable.

iii. Central fan integrated ventilation systems—systems serving individual dwelling units. Central forced air system fans used to provide outside air shall have an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.3. Central Fan Integrated Ventilation Systems shall be certified to the Energy Commission as Intermittent Ventilation Systems as specified in Reference Residential Appendix RA3.7.4.2.

a. 0.45 W/cfm for gas furnace air-handling units; or

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

iv. Balanced ventilation systems with heat/energy recovery in Climate Zones 1, 2, 4, 11–14, and 16. A balanced ventilation system with heat or energy recovery shall be used to meet Section 160.2(b)2Aivb1, and shall meet the applicable requirements of Item a or b below:

a. In Climate Zones 1, 2, 4, 11–14, and 16, balanced ventilation systems serving individual dwelling units shall:

1. Be an energy recovery ventilator (ERV) or heat recovery ventilator (HRV),

2. Have a minimum sensible recovery efficiency of 67 percent, rated at 32 degrees Fahrenheit (0 degrees Celsius), and

3. Have a fan efficacy less than or equal to 0.6 W per cfm.

These measures shall be confirmed through field verification in accordance with the procedures in RA3.7.4.4 for buildings with three habitable stories or fewer, or the procedures in NA2.2.4.1.5 for buildings with four or more habitable stories.

b. In Climate Zones 1, 2, 4, 11–14, and 16, balanced ventilation systems serving multiple dwelling units in buildings with four or more habitable stories shall:

1. Be an ERV or HRV,
2. Have a minimum sensible recovery efficiency or effectiveness of 67 percent, rated at 32 degrees Fahrenheit (0 degrees Celsius),
3. Meet the fan power requirements of Section 170.2(c)4A, and
4. Have recovery bypass or control to directly economize with ventilation air based on outdoor air temperature limits specified in Table 170.2-G.

These measures shall be field verified in accordance with NA7.18.4.

v. In buildings with three habitable stories or fewer in Climate Zones 5–10 and Climate Zone 15, when a heat pump space-conditioning system is installed to meet the requirements of Section 170.2(c)3Ai, balanced ventilation systems without an ERV or HRV shall have a fan efficacy less than or equal to 0.4 W/cfm.

vi. Dwelling unit ventilation system requirements. All HRV/ERV systems serving individual dwelling units shall have a fault indicator display (FID) that is manufacturer certified in compliance with the requirements in Joint Appendix JA17.4. The FID certification shall be verified by an ECC-Rater.

Exception to Section 170.2(c)3B: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

C. HVAC system bypass ducts. Bypass ducts that deliver conditioned supply air directly to the space-conditioning system return duct airflow shall not be used.

4. Common use area space-conditioning systems. A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the applicable requirements of Subsections A through O.

A. Fan systems. Each fan system moving air into, out of, or between spaces or circulating air for the purpose of conditioning air within a space shall meet the requirements of Items i, ii and iii below.

i. Fan power budget. For each fan system that includes at least one fan or fan array with fan electrical input power ≥ 1 kW, fan system electrical input power (Fan $kW_{design,system}$) determined per Section 170.2(c)4Aib at the fan system design airflow shall not exceed Fan kW_{budget} as calculated per Section 170.2(c)4Aia.

a. Calculation of fan power budget (Fan kW_{budget}). For each fan system:

I. Determine the fan system airflow and choose the appropriate table(s) for fan power allowance.

A. For single-cabinet fan systems, use the fan system airflow and the power allowances in both Tables 170.2-B and Table 170.2-C.

B. For supply-only fan systems, use the fan system airflow and power allowances in Table 170.2-B.

C. For relief fan systems, use the design relief airflow and the power allowances in Table 170.2-C.

D. For exhaust, return and transfer fan systems, use the fan system airflow and the power allowances in Table 170.2-C.

E. For complex fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the fan system design conditions, and the power allowances in Table 170.2-B. For the return/exhaust airflow, use return/exhaust airflow at the fan system design conditions, and the power allowances in Table 170.2-C.

II. For each fan system, determine the components included in the fan system and sum the fan power allowances of those components. All fan systems shall include the system base allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the fan power allowance for that component per this equation:

$$FPA_{adj} = \frac{Q_{comp}}{Q_{sys}} \times FPA_{comp}$$

where:

FPA_{adj} = The correct/ed fan power allowance for the component in W/cfm.

Q_{comp} = The airflow through component in cfm.

Q_{sys} = The fan system airflow in cfm.

FPA_{comp} = The fan power allowance of the component from Table 170.2-B or Table 170.2-C.

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III. Multiply the fan system airflow by the sum of the fan power allowances for the fan system.

IV. Divide by 1000 to convert to Fan kW_{budget}.

V. For building sites at elevations greater than 3,000 feet, multiply Fan kW_{budget} by the correction factor in Table 170.2-D.

b. Determining fan system electrical input power (Fan $kW_{design,system}$). Fan $kW_{design,system}$ is the sum of Fan kW_{design} for each fan or fan array included in the fan system with Fan $kW_{design} \geq 1$ kW. If variable speed drives are used, their efficiency losses shall be included. Fan input power shall be calculated with two times the clean filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The Fan kW_{design} for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:

I. Use the default Fan kW_{design} in Table 170.2-E-1 for one or more of the fans. This method cannot be used for complex fan systems.

II. Use the Fan kW_{design} at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in USDOE 10 CFR Part 430, USDOE 10 CFR Part 431, ANSI/AMCA Standard 208-2018, ANSI/AMCA Standard 210-2016, AHRI Standard 430-2020, AHRI Standard 440-2019 or ISO 5801-2017.

III. Use the Fan kW_{design} provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in Section 5.3 of ANSI/AMCA 208-2018.

IV. Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate.

ii. VAV systems.

a. Static pressure sensor location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller setpoint is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section 170.2(c)4Aiib. If this results in the sensor being located downstream of any major duct split, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint; and

b. Setpoint reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoints shall be reset based on the zone requiring the most pressure; i.e., the setpoint is reset lower until one zone damper is nearly wide open.

iii. Fractional HVAC motors for fans. HVAC motors for fans that are less than 1 hp and $^1/_{12}$ hp or greater shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

Exception 1 to Section 170.2(c)4Aiii: Motors in fan-coils and terminal units that operate only when providing heating to the space served.

Exception 2 to Section 170.2(c)4Aiii: Motors in space-conditioning equipment certified under Section 110.1 or 110.2.

Exception 1 to 170.2(c)4A: Fan system power caused solely by process loads.

B. **Space-conditioning zone controls.** Each space-conditioning zone shall have controls designed in accordance with i or ii:

i. Each space-conditioning zone shall have controls that prevent:

a. Reheating; and

b. Recooling; and

c. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled either by cooling equipment or by economizer systems; or

ii. Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled or mixed air are allowed only if the controls meet all of the following requirements:

a. For each zone with direct digital controls (DDC), the volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of:

I. 50 percent of the peak primary airflow; or

II. The design zone outdoor airflow rate as specified by Section 160.2(c)3.

b. The volume of primary air in the deadband shall not exceed the design zone outdoor airflow rate as specified by Section 160.2(c)3.

c. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint no higher than 95°F while the airflow is maintained at the deadband flow rate.

d. The second stage of heating consists of modulating the airflow rate from the deadband flow rate up to the heating maximum flow rate.

e. For each zone without DDC, the volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of the following:
   I. 30 percent of the peak primary airflow; or
   II. The design zone outdoor airflow rate as specified by Section 160.2(c)3.

Exception 1 to Section 170.2(c)4B: Zones with special pressurization relationships or cross-contamination control needs.

Exception 2 to Section 170.2(c)4B: Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

Exception 3 to Section 170.2(c)4B: Zones in which specific humidity levels are required to satisfy exempt process loads. Computer rooms or other spaces where the only process load is from IT equipment may not use this exception.

Exception 4 to Section 170.2(c)4B: Zones with a peak supply-air quantity of 300 cfm or less.

TABLE 170.2-C—EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (WATT/CFM)

	MULTI-ZONE VAV SYSTEMS ≤ 5,000 cfm	MULTI-ZONE VAV SYSTEMS > 5,000 and ≤ 10,000 cfm[1]	MULTI-ZONE VAV SYSTEMS > 10,000 cfm[1]	ALL OTHER FAN SYSTEMS ≤ 5,000 cfm	ALL OTHER FAN SYSTEMS > 5,000 and ≤ 10,000 cfm	ALL OTHER FAN SYSTEMS > 10,000 cfm
Exhaust System Base Allowance	0.221	0.246	0.236	0.186	0.184	0.190
Filter (any MERV value)[2]	0.046	0.041	0.036	0.046	0.041	0.035
Energy Recovery Allowance for 0.50 ≤ ERR < 0.55[3]	0.139	0.120	0.107	0.139	0.123	0.109
Energy Recovery Allowance for 0.55 ≤ ERR < 0.60[3]	0.165	0.142	0.126	0.165	0.144	0.128
Energy Recovery Allowance for 0.60 ≤ ERR < 0.65[3]	0.190	0.163	0.146	0.191	0.166	0.148
Energy Recovery Allowance for 0.65 ≤ ERR < 0.70[3]	0.215	0.184	0.165	0.216	0.188	0.167
Energy Recovery Allowance for 0.70 ≤ ERR < 0.75[3]	0.240	0.206	0.184	0.241	0.209	0.186
Energy Recovery Allowance for 0.75 ≤ ERR < 0.80[3]	0.265	0.227	0.203	0.266	0.231	0.205
Energy Recovery Allowance for ERR ≥ 0.80[3]	0.289	0.248	0.222	0.291	0.252	0.225
Coil Runaround Loop	0.139	0.120	0.107	0.139	0.123	0.109
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.116	0.100	0.089	0.116	0.102	0.091
Return and/or exhaust airflow control devices required for space pressurization control	0.116	0.100	0.089	0.116	0.102	0.091
Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 ft. Value shown is allowed W/cfm per 0.25 in. wg for each 100 feet exceeding 75 feet. [Calculation required, see Note 4]	0.058	0.051	0.045	0.058	0.052	0.046
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop. [Calculation required, see Note 4]	0.231	0.198	0.177	0.232	0.202	0.179
Exhaust filters, scrubbers or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop. [Calculation required, see Note 4]	0.231	0.198	0.177	0.232	0.202	0.179
Sound attenuation section [Fans serving spaces with design background noise goals below NC35]	0.035	0.030	0.027	0.035	0.031	0.028

1. For requirements to be classified as a multi-zone VAV system, see definition for "Multi-zone variable air volume fan system."
2. Filter pressure loss can only be counted once per fan system.
3. Energy recovery ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
4. Power allowance requires further calculation, multiplying the actual pressure drop (in. wg) of the device/component by the watts/cfm in Table 170.2-C.

TABLE 170.2-D—AIR DENSITY CORRECTION FACTORS

ALTITUDE (ft)	CORRECTION FACTOR
< 3,000	1.000
≥ 3,000 and < 4,000	0.896
≥ 4,000 and < 5,000	0.864
≥ 5,000 and < 6,000	0.832
≥ 6,000	0.801

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TABLE 170.2-E-1—DEFAULT VALUES FOR FAN KW_{DESIGN} BASED ON MOTOR NAMEPLATE HP		
MOTOR NAMEPLATE HP	**DEFAULT FAN KW_{DESIGN} WITH VARIABLE SPEED DRIVE (FAN KW_{DESIGN})**	**DEFAULT FAN KW_{DESIGN} WITHOUT VARIABLE SPEED DRIVE (FAN KW_{DESIGN})**
< 1	0.96	0.89
≥ 1 and < 1.5	1.38	1.29
≥ 1.5 and < 2	1.84	1.72
≥ 2 and < 3	2.73	2.57
≥ 3 and < 5	4.38	4.17
≥ 5 and < 7.5	6.43	6.15
≥ 7.5 and < 10	8.46	8.13
≥ 10 and < 15	12.47	12.03
≥ 15 and < 20	16.55	16.04
≥ 20 and < 25	20.58	19.92
≥ 25 and < 30	24.59	23.77
≥ 30 and < 40	32.74	31.70
≥ 40 and < 50	40.71	39.46
≥ 50 and < 60	48.50	47.10
≥ 60 and < 75	60.45	58.87
≥ 75 and ≤ 100	80.40	78.17

1. This table cannot be used for motor nameplate horsepower values greater than 100.
2. This table is to be used only with motors with a service factor ≤ 1.15. If the service factor is not provided, this table may not be used.

C. **Economizers**.

i. Each cooling air handler that has a design total mechanical cooling capacity over 33,000 Btu/hr, or chilled-water cooling systems without a fan or that use induced airflow that has a cooling capacity greater than the systems listed in Table 170.2-E-2, shall include either:

a. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside air; or

b. A water economizer capable of providing 100 percent of the expected system cooling load, at outside air temperatures of 50°F dry-bulb and 45°F wet-bulb and below.

Exception 1 to Section 170.2(c)4Ci: Where special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

Exception 2 to Section 170.2(c)4Ci: Where the use of outdoor air for cooling will affect other systems, such as humidification or dehumidification, so as to increase overall building LSC energy use.

Exception 3 to Section 170.2(c)4Ci: Systems serving dwelling units.

Exception 4 to Section 170.2(c)4Ci: Where comfort cooling systems have the cooling efficiency that meets or exceeds the cooling efficiency improvement requirements in Table 170.2-F.

Exception 5 to Section 170.2(c)4Ci: Fan systems primarily serving computer rooms. See Section 140.9(a) for computer room economizer requirements.

Exception 6 to Section 170.2(c)4Ci: In all climate zones, each air handler that has a design total mechanical cooling capacity less than 54,000 Btu/h where ventilation is provided by a dedicated outdoor air system (DOAS) with exhaust air heat recovery in accordance with Section 140.4(p) and the following:

A. The DOAS unit shall meet the exhaust air heat recovery ratio as specified in Section 140.4(q)1 and include bypass or control to disable energy recovery as specified in Section 140.4(q)2.

B. The DOAS unit shall provide at least the minimum ventilation airflow rate as specified in Section 120.1(c)3 and provide no less than 0.3 cfm/ft^2 during economizer conditions.

TABLE 170.2-E-2—CHILLED WATER SYSTEM COOLING CAPACITY		
CLIMATE ZONES	**TOTAL BUILDING CHILLED WATER SYSTEM CAPACITY, MINUS CAPACITY OF THE COOLING UNITS WITH AIR ECONOMIZERS**	
	Building Water-Cooled Chilled Water System	**Air-Cooled Chilled Water Systems or District Chilled Water Systems**
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1–14	≥ 720,000 Btu/h (210 kW)	≥ 940,000 Btu/h (275 kW)
16	≥ 1,320,000 Btu/h (385 kW)	≥ 1,720,000 Bu/h (505 kW)

TABLE 170.2-F—ECONOMIZER TRADE-OFF TABLE FOR COOLING SYSTEMS	
CLIMATE ZONE	EFFICIENCY IMPROVEMENT[a]
1	70%
2	65%
3	65%
4	65%
5	70%
6	30%
7	30%
8	30%
9	30%
10	30%
11	30%
12	30%
13	30%
14	30%
15	30%
16	70%

a. If a unit is rated with an annualized or part-load metric, then to eliminate the required economizer, only the annualized or part-load minimum cooling efficiency of the unit must be increased by the percentage shown. If the unit is only rated with a full load metric, like EER2 or COP cooling, then that metric must be increased by the percentage shown. To determine the efficiency required to eliminate economizer, when the unit equipment efficiency is rated with an energy-input divided by work-output metric, the metric shall first be converted to COP prior to multiplying by the efficiency improvement percentage and then converted back to the rated metric.

ii. If an economizer is required by Section 170.2(c)4Ci, and an air economizer is used to meet the requirement, then it shall be:

a. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

Exception to Section 170.2(c)4Ciia: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

b. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

c. Designed and equipped with a device type and high limit shut off complying with Table 170.2-G.

TABLE 170.2-G—AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS			
DEVICE TYPE[a]	CLIMATE ZONES	REQUIRED HIGH LIMIT (Economizer Off When):	REQUIRED HIGH LIMIT (Economizer Off When):
		Equation[b]	Description
Fixed Dry Bulb	1, 3, 5, 11–16	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
Fixed Dry Bulb	2, 4, 10	T_{OA} > 73°F	Outdoor air temperature exceeds 73°F
Fixed Dry Bulb	6, 8, 9	T_{OA} > 71°F	Outdoor air temperature exceeds 71°F
Fixed Dry Bulb	7	T_{OA} > 69°F	Outdoor air temperature exceeds 69°F
Differential Dry Bulb	1, 3, 5, 11–16	T_{OA} > T_{RA}°F	Outdoor air temperature exceeds return air temperature
Differential Dry Bulb	2, 4, 10	T_{OA} > T_{RA}–2°F	Outdoor air temperature exceeds return air temperature minus 2°F
Differential Dry Bulb	6, 8, 9	T_{OA} > T_{RA}–4°F	Outdoor air temperature exceeds return air temperature minus 4°F
Differential Dry Bulb	7	T_{OA} > T_{RA}–6°F	Outdoor air temperature exceeds return air temperature minus 6°F
Fixed Enthalpy[c] + Fixed Dry Bulb	All	h_{OA} > 28 Btu/lb[c] or T_{OA} > 75°F	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[c] or Outdoor air temperature exceeds 75°F

a. Only the high limit control devices listed are allowed to be used and at the setpoints listed. Others, such as Dew Point, Fixed Enthalpy, Electronic Enthalpy and Differential Enthalpy Controls, may not be used in any climate zone for compliance with Section 170.2(c)4Ci unless approval for use is provided by the Energy Commission Executive Director.

b. Devices with selectable (rather than adjustable) setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

c. At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6,000 foot elevation, the fixed enthalpy limit is approximately 30.7 Btu/lb.

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iii. The air economizer and all air dampers shall have the following features:

a. **Warranty.** 5-year manufacturer warranty of economizer assembly.

b. **Damper reliability testing.** Suppliers of economizers shall certify that the economizer assembly, including but not limited to outdoor air damper, return air damper, drive linkage and actuator, has been tested and is able to open and close against the rated airflow and pressure of the system for 60,000 damper opening and closing cycles.

c. **Damper leakage.** Economizer outdoor air and return air dampers shall have a maximum leakage rate of 10 cfm/sf at 250 Pascals (1.0 in. of water) when tested in accordance with AMCA Standard 500-D. The economizer outside air and return air damper leakage rates shall be certified to the Energy Commission in accordance with Section 110.0.

d. **Adjustable setpoint.** If the high-limit control is fixed dry-bulb or fixed enthalpy + fixed dry-bulb then the control shall have an adjustable setpoint.

e. **Sensor accuracy.** Outdoor air, return air, mixed air and supply air sensors shall be calibrated within the following accuracies.

I. Dry bulb and wet bulb temperatures accurate to ±2°F over the range of 40°F to 80°F;

II. Enthalpy accurate to ±3 Btu/lb over the range of 20 Btu/lb to 36 Btu/lb;

III. Relative humidity (RH) accurate to ±5 percent over the range of 20 percent to 80 percent RH.

f. **Sensor calibration data.** Data used for control of the economizer shall be plotted on a sensor performance curve.

g. **Sensor high limit control.** Sensors used for the high limit control shall be located to prevent false readings, including but not limited to being properly shielded from direct sunlight.

h. **Relief air system.** Relief air systems shall be capable of providing 100 percent outside air without overpressurizing the building.

iv. The space-conditioning system shall include the following:

a. Unit controls shall have mechanical capacity controls interlocked with economizer controls such that the economizer is at 100 percent open position when mechanical cooling is on and does not begin to close until the leaving air temperature is less than 45°F.

b. Direct Expansion (DX) units greater than 65,000 Btu/hr that control the capacity of the mechanical cooling directly based on occupied space temperature shall have a minimum of two stages of mechanical cooling capacity.

c. DX units not within the scope of Section 170.2(c)4Ciib shall (i) comply with the requirements in Table 170.2-H, and (ii) have controls that do not false load the mechanical cooling system by limiting or disabling the economizer or by any other means except at the lowest stage of mechanical cooling capacity.

TABLE 170.2-H—DIRECT EXPANSION (DX) UNIT REQUIREMENTS FOR COOLING STAGES AND COMPRESSOR DISPLACEMENT

COOLING CAPACITY	MINIMUM NUMBER OF MECHANICAL COOLING STAGES	MINIMUM COMPRESSOR DISPLACEMENT
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

v. Systems that include a water economizer to meet Section 170.2(c)4Ci shall include the following:

a. Maximum pressure drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer shall either have a waterside pressure drop of less than 15 feet of water, or a secondary loop shall be installed so that the coil or heat exchanger pressure drop is not contributing to pressure drop when the system is in the normal cooling (noneconomizer) mode.

b. Economizer systems shall be integrated with the mechanical cooling system so that they are capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling system by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

D. **Supply air temperature reset controls.** Space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply-air temperatures. Air distribution systems serving zones that are likely to have constant loads shall be designed for the air flows resulting from the fully reset supply air temperature. Supply air temperature reset controls shall be:

i. In response to representative building loads or to outdoor air temperature; and

ii. At least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

Exception 1 to Section 170.2(c)4D: Systems that meet the requirements of Section 170.2(c)3Bi, without using Exception 1 to that section.

Exception 2 to Section 170.2(c)4D: Where supply-air temperature reset would increase overall building energy use.

Exception 3 to Section 170.2(c)4D: Systems supplying zones in which specific humidity levels are required to satisfy process loads. Computer rooms or other spaces with only IT equipment may not use this exception.

E. **Electric-resistance heating.** Electric-resistance heating systems shall not be used for space heating.

Exception 1 to Section 170.2(c)4E: Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

Exception 2 to Section 170.2(c)4E: Where an electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 170.2(c)1 at the design outdoor temperature specified in Section 170.2(c)2.

Exception 3 to Section 170.2(c)4E: Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

Exception 4 to Section 170.2(c)4E: Where the total capacity of all electric-resistance heating systems serving the entire building, excluding those allowed under Exception 2, is no more than 3 kW.

Exception 5 to Section 170.2(c)4E: Heating systems serving as emergency backup to gas heating equipment.

F. **Heat rejection systems.** Heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers and evaporative condensers shall include the following:

i. **Fan speed control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at $^{2}/_{3}$ of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature or pressure of the heat rejection device.

Exception 1 to Section 170.2(c)4Fi: Heat rejection devices included as an integral part of the equipment listed in Table 110.2-A through Table 110.2-N.

Exception 2 to Section 170.2(c)4Fi: Condenser fans serving multiple refrigerant circuits.

Exception 3 to Section 170.2(c)4Fi: Condenser fans serving flooded condensers.

Exception 4 to Section 170.2(c)4Fi: Up to one-third of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.

ii. **Tower flow turndown.** Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

a. The flow that is produced by the smallest pump; or

b. 50 percent of the design flow for the cell.

iii. **Limitation on centrifugal fan cooling towers.** Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall use propeller fans and shall not use centrifugal fans.

Exception 1 to Section 170.2(c)4Fiii: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

Exception 2 to Section 170.2(c)4Fiii: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 110.2, Table 110.2-F.

iv. **Multiple cell heat rejection equipment.** Multiple cell heat rejection equipment with variable speed fan drives shall:

a. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components, and

b. Control all operating fans to the same speed. Minimum fan speed shall comply with the minimum allowable speed of the fan drive as specified by the manufacturer's recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.

v. **Cooling tower efficiency.** Axial fan, open-circuit cooling towers serving condenser water loops for chilled water plants with a total of 900 gpm or greater shall have a minimum rated efficiency based on Table 170.2-I when rated in accordance with the conditions as listed in Table 110.2-F.

TABLE 170.2-I—MINIMUM EFFICIENCY FOR PROPELLER OR AXIAL FAN OPEN-CIRCUIT COOLING TOWERS (gpm/hp)

CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
42.1	70	60	70	70	80	80	80	80	80	60	70	80	60	80	42.1

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Exception 1 to Section 170.2(c)4Fv: Replacement of existing cooling towers that are inside an existing building or on an existing roof.

G. **Minimum chiller efficiency.** Chillers shall meet or exceed Path B from Table 110.2-D.

Exception 1 to Section 170.2(c)4G: Chillers with electrical service > 600 V.

Exception 2 to Section 170.2(c)4G: Chillers attached to a heat recovery system with a design heat recovery capacity > 40 percent of the design chiller cooling capacity.

Exception 3 to Section 170.2(c)4G: Chillers used to charge thermal energy storage systems where the charging temperature is < 40°F.

Exception 4 to Section 170.2(c)4G: In buildings with more than three chillers, only three chillers are required to meet the Path B efficiencies.

H. **Limitation of air-cooled chillers.** Chilled water plants shall not have more than 300 tons provided by air-cooled chillers.

Exception 1 to Section 170.2(c)4H: Where the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled chillers.

Exception 2 to Section 170.2(c)4H: Chillers that are used to charge a thermal energy storage system with a design temperature of less than 40°F (4°C).

I. **Hydronic system measures**.

i. **Hydronic variable flow systems.** HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50 percent or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

Exception 1 to Section 170.2(c)4I: Systems that include no more than three control valves.

Exception 2 to Section 170.2(c)4I: Systems having a total pump system power less than or equal to 1.5 hp.

ii. **Chiller isolation.** When a chilled water system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.

iii. **Boiler isolation.** When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).

iv. **Chilled and hot water temperature reset controls.** Systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

Exception to Section 170.2(c)4Iiv: Hydronic systems that use variable flow to reduce pumping energy in accordance with Section 170.2(c)4Ii.

v. **Water-cooled air conditioner and hydronic heat pump systems.** Water circulation systems serving water-cooled air conditioners, hydronic heat pumps or both, that have total pump system power exceeding 5 hp, shall have flow controls that meet the requirements of Section 170.2(c)4Ivi. Each such air conditioner or heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

vi. **Variable flow controls.**

a. Variable speed drives. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls or devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pumps shall be controlled as a function of required differential pressure.

b. Pressure sensor location and setpoint.

I. For systems without direct digital control of individual coils reporting to the central control panel, differential pressure shall be measured at the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

II. For systems with direct digital control of individual coils with a central control panel, the static pressure setpoint shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80 percent open. Pressure sensors may be mounted anywhere.

Exception 1 to Section 170.2(c)4Ivi: Heating hot water systems.

Exception 2 to Section 170.2(c)4Ivi: Condenser water systems serving only water-cooled chillers.

vii. **Hydronic heat pump (WLHP) controls.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature deadband of at least 20°F between initiation of heat rejection and heat addition by the central devices.

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Exception to Section 170.2(c)4Ivii: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, deadbands of less than 20°F shall be allowed**.**

J. Reserved.

K. **Fan control.** Each cooling system listed in Table 170.2-H shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

i. DX and chilled water cooling systems that control the capacity of the mechanical cooling directly based on occupied space temperature shall (i) have a minimum of two stages of fan control with no more than 66 percent speed when operating on stage 1; and (ii) draw no more than 40 percent of the fan power at full fan speed, when operating at 66 percent speed.

ii. All other systems, including but not limited to DX cooling systems and chilled water systems that control the space temperature by modulating the airflow to the space, shall have proportional fan control such that at 50 percent air flow the power draw is no more than 30 percent of the fan power at full fan speed.

iii. Systems that include an air side economizer to meet Section 170.2(c)4Ci shall have a minimum of two speeds of fan control during economizer operation.

Exception to Section 170.2(c)4K: Modulating fan control is not required for chilled water systems with all fan motors <1 HP, or for evaporative systems with all fan motors < 1 HP, if the systems are not used to provide ventilation air and all indoor fans cycle with the load.

L. **Mechanical system shut-off.** Any directly conditioned common use area space with operable wall or roof openings to the outdoors shall be provided with interlock controls that disable or reset the temperature setpoint to 55°F for mechanical heating and disable or reset the temperature setpoint to 90°F for mechanical cooling to that space when any such opening is open for more than 5 minutes.

Exception 1 to Section 170.2(c)4L: Interlocks are not required on doors with automatic closing devices.

Exception 2 to Section 170.2(c)4L: Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space).

M. **Exhaust system transfer air**. Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

i. The supply flow required to meet the space heating or cooling load; or

ii. The ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety Department or Section 160.2(c)3; or

iii. The mechanical exhaust flow minus the available transfer air. Available transfer air shall be from another conditioned space or return air plenums on the same floor and same smoke or fire compartment, and that at their closest point are within 15 feet of each other.

Exception 1 to Section 170.2(c)4M: Spaces that are required by applicable codes and standards to be maintained at a positive pressure differential relative to adjacent spaces.

Exception 2 to Section 170.2(c)4M: Spaces where the highest amount of transfer air that could be used for exhaust makeup may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship.

N. **Dedicated outdoor air systems (DOAS).** HVAC systems that utilize a dedicated outdoor air system (DOAS) such as a DX-DOAS, HRV or ERV unit to condition, temper or filter 100 percent outdoor air separate from local or central space-conditioning systems serving the same space shall meet the following criteria:

1. DOAS unit fan systems with input power less than 1 kW shall not exceed a total combined fan power of 1.0 W/cfm. DOAS with fan power greater than or equal to 1 kW shall meet the requirements of Section 140.4(c).

2. The DOAS supply air shall be delivered directly to the occupied space or at the outlet of any terminal heating or cooling coils and shall cycle off any zone heating and cooling equipment fans, circulation pumps and terminal unit fans when there is no call for heating or cooling in the zone.

Exception 1 to Section 170.2(c)4N2: Active chilled beam systems.

Exception 2 to Section 170.2(c)4N2: Sensible-only cooling terminal units with pressure-independent variable-airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.

Exception 3 to Section 170.2(c)4N2: Any configuration where a DOAS unit provides ventilation air to a downstream fan (a terminal box, air handling unit or other space-conditioning equipment) where the total system airflow can be reduced to ventilation minimum or the downstream fan power is no greater than 0.12 watts per cfm when space temperatures are within the thermostat deadband (at low speed per manufacturer's literature).

3. DOAS supply and exhaust fans shall have a minimum of three speeds to facilitate system balancing.

4. DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 60°F when representative building loads or outdoor air temperature indicates that the majority of zones requires cooling.

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O. **Exhaust air heat recovery.** Fan systems designed to operate to the criteria listed in either Table 170.2-I or Table 170.2-J shall include an exhaust air heat recovery system that meets the following:

i. A sensible energy recovery ratio of at least 60 percent or an enthalpy recovery ratio of at least 50 percent for both heating and cooling design conditions.

ii. Energy recovery bypass or control to disable energy recovery and to directly economize with ventilation air based on outdoor air temperature limits specified in Table 170.2-G. For energy recovery systems where the transfer of energy cannot be stopped, bypass shall prevent the total airflow rate of either outdoor air or exhaust air through the energy recovery exchanger from exceeding 10 percent of the full design airflow rate.

iii. For a DOAS unit and a separate independent space-conditioning system meeting the requirements of Section 170.2(c)4Nia, the design supply fan airflow rate shall be the total airflow of only the DOAS unit.

Exception to Section 170.2(c)4Oii: DOAS units with the capability to shut off when a separate independent space-conditioning system meets the economizer requirements specified by Section 170.2(c)4Cia is economizing.

Exception 1 to Section 170.2(c)4O: Systems meeting Section 140.9(c) prescriptive requirements for laboratory and factory exhaust systems.

Exception 2 to Section 170.2(c)4O: Systems serving spaces that are not cooled and that are heated to less than 60°F.

Exception 3 to Section 170.2(c)4O: Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy in Climate Zone 16.

Exception 4 to Section 170.2(c)4O: Sensible recovery ratio requirements at heating design conditions are not required for Climate Zone 15.

Exception 5 to Section 170.2(c)4O: Sensible recovery ratio requirements at cooling design conditions are not required for Climate Zone 1.

Exception 6 to Section 170.2(c)4O: Where the sum of the airflow rates exhausted and relieved within 20 feet of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is either:

i. Used for another energy recovery system;

ii. Not allowed by the *California Mechanical Code* (Title 24, Part 4) for use in energy recovery systems with leakage potential; or

iii. Of Class 4 as specified in Section 160.2(c)8.

Exception 7 to Section 170.2(c)4O: Systems expected to operate less than 20 hours per week.

TABLE 170.2-I—ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (<8,000 HOURS / YEAR)

% OUTDOOR AIR AT FULL DESIGN AIRFLOW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥10% and <20%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
≥20% and <30%	≥15,000	≥20,000	NR	NR	NR	NR	NR	NR	NR	NR	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500
≥30% and <40%	≥13,000	≥15,000	NR	NR	NR	NR	NR	NR	NR	NR	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000
≥40% and <50%	≥10,000	≥12,000	NR	NR	NR	NR	NR	NR	NR	≥22,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000
≥50% and <60%	≥9,000	≥10,000	NR	≥18,500	NR	NR	NR	NR	NR	≥17,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000
≥60% and <70%	≥7,000	≥7,500	NR	≥16,500	NR	NR	NR	NR	≥20,000	≥15,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000
≥70% and <80%	≥6,500	≥7,000	NR	≥15,000	NR	NR	NR	NR	≥17,000	≥14,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥80%	≥4,500	≥6,500	NR	≥14,000	NR	NR	NR	NR	≥15,000	≥13,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

TABLE 170.2-J—ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (≥8,000 HOURS / YEAR)

% OUTDOOR AIR AT FULL DESIGN AIRFLOW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥10% and <20%	≥10,000	≥10,000	NR	NR	NR	NR	NR	NR	NR	≥40,000	≥40,000	≥20,000	≥10,000	≥10,000	≥10,000	≥10,000
≥20% and <30%	≥2,000	≥5,000	≥13,000	≥9,000	≥9,000	NR	NR	NR	NR	≥15,000	≥15,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥30% and <40%	≥2,000	≥3,000	≥10,000	≥6,500	≥6,500	NR	NR	NR	≥15,000	≥7,500	≥7,500	≥3,000	≥3,000	≥3,000	≥3,000	≥3,000
≥40% and <50%	≥2,000	≥2,000	≥8,000	≥6,000	≥6,000	NR	NR	NR	≥12,000	≥6,000	≥6,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥50% and <60%	≥2,000	≥2,000	≥7,000	≥6,000	≥6,000	NR	NR	≥20,000	≥10,000	≥5,000	≥5,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥60% and <70%	≥2,000	≥2,000	≥6,000	≥6,000	≥6,000	NR	NR	≥18,000	≥9,000	≥4,000	≥4,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥70% and <80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥15,000	≥8,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥12,000	≥7,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

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(d) **Domestic hot water systems.** Water-heating systems shall meet the applicable requirements of 1 or 2 below:

1. **Individual systems.** For systems serving individual dwelling units, the water-heating system shall meet the requirement of either A or B, or shall meet the performance compliance requirements of Section 170.1. For recirculation distribution systems serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be used.
   A. A single 240 volt heat pump water heater. In addition, meet the following:
      i. A compact hot water distribution system as specified in Reference Appendix RA4.4.6 in Climate Zones 1 and 16; and
      ii. A drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 in Climate Zone 16.
   B. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher. In addition, for Climate Zone 16, a drain water heat recovery system that is field verified as specified in Reference Appendix RA3.6.9.

   Exception 1 to Section 170.2(d)1: Multifamily buildings four habitable stories or greater may install a gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank.

   Exception 2 to Section 170.2(d)1: A 120V HPWH may be installed in place of a 240V HPWH for new dwelling units with one bedroom or less.
2. **Central systems.** For systems serving multiple dwelling units, the water-heating system shall meet the applicable requirement of A through F, or shall meet the performance compliance requirements of Section 170.1:
   A. For heat pump water-heating systems serving multiple dwelling units, the water-heating system shall be installed according to the manufacturer's design and installation guidelines and meet the following requirements, or meet the requirements of NEEA Advanced Water Heater Specification for commercial heat pump water heater Tier 2 or higher:
      i. The primary heat pump water heater shall be a single-pass heat pump water heater.
      ii. The hot water return from the recirculation loop shall connect to a recirculation loop tank and shall not directly connect to the primary heat pump water heater inlet or the primary thermal storage tanks.
      iii. The fuel source for the recirculation loop tank shall be electricity.
      iv. The primary storage tank temperature setpoint shall be at least 135°F.
      v. The recirculation loop tank temperature setpoint shall be at least 10°F lower than the primary thermal storage tank temperature setpoint.
      vi. The minimum heat pump water heater compressor cut-off temperature shall be equal to or lower than 40°F ambient air temperature.
      vii. Design documentation shall be provided in accordance with JA14.4.
   B. For gas or propane systems serving multiple dwelling units, the water-heating system that includes the following components shall be installed:
      i. For Climate Zones 1 through 9, gas service water-heating systems with a total installed gas water-heating input capacity of 1 MMBtu/h or greater shall have gas service water-heating equipment with a minimum thermal efficiency of 90 percent. Multiple units are allowed to meet this requirement with an input capacity-weighted average of at least 90 percent.

         Exception 1 to Section 170.2(d)Bi: Individual gas water heaters with input capacity at or below 100,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

         Exception 2 to Section 170.2(d)Bi: If 25 percent of the annual water-heating requirement is provided by site-solar energy or site-recovered energy.
      ii. A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum solar savings fraction of either a. or b. below:
         a. A minimum solar savings fraction of 0.20 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.35 in Climate Zones 10 through 16; or
         b. A minimum solar savings fraction of 0.15 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.30 in Climate Zones 10 through 16. In addition, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.
   C. All hot water piping shall be sized in accordance with the *California Plumbing Code* Appendix M.
   D. The central system shall have a recirculation system with a mechanical or digital thermostatic master mixing valve on each distribution supply and return loop, and meet the requirements specified in the Residential Reference Appendix RA4.4.19.

      Exception to Section 170.2(d)2D: Buildings with eight or fewer dwelling units.
   E. Insulation for hot water pipes and plumbing appurtenances shall be field verified as specified in Residential Reference Appendix RA3.6.3.
   F. A water-heating system serving multiple dwelling units determined by the Executive Director to use no more energy than the one specified in Subsection A or B above.

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TABLE 170.2-K—MECHANICAL COMPONENT PACKAGE – MULTIFAMILY STANDARD BUILDING DESIGN

COMPONENT	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Unitary[4] – Balanced Ventilation System[1] HRV/ERV Sensible Recovery Efficiency	0.67	0.67	NR	0.67	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	NR	0.67
Unitary[4] – Balanced Ventilation System[1] HRV/ERV Fan Efficacy (W/cfm)	0.6	0.6	1.0	0.6	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.6	0.6	0.6	1.0	0.6
Unitary[4] – Balanced Ventilation System[1] Non-HRV/ERV Fan Efficacy (W/cfm)	NR	NR	NR	NR	0.4	0.4	0.4	0.4	0.4	0.4	NR	NR	NR	NR	0.4	NR
Unitary[4] – Heat Pump[3], HSPF2[2]	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Unitary[4] – Dual-Fuel Heat Pump[3], AFUE	MIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	MIN
Unitary[4] – Refrigerant Charge Verification or Fault Indicator Display	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Unitary[4] – SEER2	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Central[5] - Balanced Ventilation Systems[1] Sensible Recovery Efficiency or Effectiveness	0.67	0.67	NR	0.67	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	NR	0.67
Central[5] - Balanced Ventilation Systems[1] Bypass Function	REQ	REQ	NR	REQ	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	NR	REQ
Central[5] – Central Fan Integrated Ventilation System Fan Efficacy	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Duct Insulation in Unconditioned Space	R 8	R 8	R 6	R 8	R 6	R 6	R 6	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8
Water Heating - All Buildings System Shall meet Section 170.2(d)	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ

1. Requirements only apply when using Balanced Ventilation to meet 160.2(b)2Aivb.
2. HSPF2 means "heating seasonal performance factor."
3. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/h and is controlled by a time-limiting device not exceeding 30 minutes.
4. Unitary system serving one dwelling unit
5. Central system serving multiple dwelling units

(e) **Lighting.** Dwelling unit lighting shall meet the applicable mandatory requirements of Section 160.5(a). Common use area lighting shall meet the following requirements:

Exception to Section 170.2(e): Common use areas providing shared provisions for living, eating, cooking or sanitation to dwelling units that would otherwise lack these provisions may instead comply with Section 160.5(a).

1. **Interior common use area lighting.** A building complies with Section 170.2(e)1 if:
   A. The calculation of adjusted indoor lighting power of all proposed building areas combined, calculated under Subsection 170.2(e)2, is no greater than the calculation of allowed indoor lighting power, specific methodologies calculated under Subsection 170.2(e)4; and
   B. The calculation of allowed indoor lighting power, general rules comply with Subsection 170.2(e)3.

   The prescriptive limits on indoor lighting power are the smaller of the actual and allowed indoor lighting power values determined in accordance with Item A.
2. **Calculation of Adjusted Indoor Lighting Power.** The Adjusted Indoor Lighting Power of all proposed building areas is the total watts of all planned permanent and portable lighting systems in all areas of the proposed building; subject to the applicable adjustments under Subdivisions A through D of this subsection.
   A. **Two interlocked lighting systems**: No more than two lighting systems may be used for an area, and if there are two they must be interlocked. Where there are two interlocked lighting systems, the watts of the lower wattage system may be excluded from the Adjusted Indoor Lighting Power if:
      i. An installation certificate detailing compliance with Section 170.2(e)1A is submitted in accordance with Section 10-103 and Section 160.5(e); and
      ii. The area (or areas) served by the interlocking systems is an auditorium, a conference room, a multipurpose room or a theater; and
      iii. The two lighting systems are interlocked with a nonprogrammable double-throw switch to prevent simultaneous operation of both systems.

For compliance with Part 6, a nonprogrammable double-throw switch is an electrical switch commonly called a "single pole double throw" or "three-way" switch that is wired as a selector switch allowing one of two loads to be enabled. It can be a line voltage switch or a low voltage switch selecting between two relays. It cannot be overridden or changed in any manner that would permit both loads to operate simultaneously.

B. **Reduction of wattage through controls.** In calculating Adjusted Indoor Lighting Power, the installed watts of a luminaire providing general lighting in an area listed in Table 170.2-L may be reduced by the product of (i) the number of watts controlled as described in Table 170.2-L, times (ii) the applicable power adjustment factor (PAF), if all of the following conditions are met:

i. An installation certificate is submitted in accordance with Section 160.5(e)2; and

ii. Luminaires and controls meet the applicable requirements of Section 110.9 and Sections 160.5(b) through 160.6; and

iii. The controlled lighting is permanently installed general lighting systems and the controls are permanently installed nonresidential-rated lighting controls.

When used for determining PAFs for general lighting in offices, furniture mounted luminaires that comply with all of the following conditions shall qualify as permanently installed general lighting systems:

a. The furniture mounted luminaires shall be permanently installed no later than the time of building permit inspection; and

b. The furniture mounted luminaires shall be permanently hardwired; and

c. The furniture mounted lighting system shall be designed to provide indirect general lighting; and

d. Before multiplying the installed watts of the furniture mounted luminaire by the applicable PAF, 0.3 watts per square foot of the area illuminated by the furniture mounted luminaires shall be subtracted from installed watts of the furniture mounted luminaires; and

e. The lighting control for the furniture mounted luminaire complies with all other applicable requirements in Section 170.2(e)2B.

iv. At least 50 percent of the light output of the controlled luminaire is within the applicable area listed in Table 170.2-L. Luminaires on lighting tracks shall be within the applicable area in order to qualify for a PAF.

v. Only one PAF from Table 170.2-L may be used for each qualifying luminaire. PAFs shall not be added together unless allowed in Table 170.2-L.

vi. Only lighting wattage directly controlled in accordance with Section 170.2(e)2B shall be used to reduce the installed watts as allowed by Section 170.2(e)2B for calculating the Adjusted Indoor Lighting Power. If only a portion of the wattage in a luminaire is controlled in accordance with Section 170.2(e)2B, then only that portion of controlled wattage may be reduced in calculating Adjusted Indoor Lighting Power.

vii. Lighting controls used to qualify for a PAF shall be designed and installed in addition to manual, multilevel and automatic lighting controls required in Section 160.5(b)4, and in addition to any other lighting controls required by any provision of Part 6. PAFs shall not be available for lighting controls required by Part 6.

viii. To qualify for the PAF for daylight continuous dimming plus OFF control, the daylight control and controlled luminaires shall comply with Sections 160.5(b)4D, 160.5(e)1C and 160.5(e)1G, and the controls shall be continuous dimming and shall additionally turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power. The PAF shall apply to the luminaires in the primary sidelit daylit zone, secondary sidelit daylit zone and skylit daylit zone.

ix. To qualify for the PAF for an occupant sensing control controlling the general lighting in large office areas above workstations, in accordance with Table 170.2-L, the following requirements shall be met:

a. The office area shall be greater than 250 square feet; and

b. This PAF shall be available only in office areas that contain workstations; and

c. Controlled luminaires shall only be those that provide general lighting directly above the controlled area, or furniture mounted luminaires that comply with Section 170.2(e)1Aii and provide general lighting directly above the controlled area; and

d. Qualifying luminaires shall be controlled by occupant sensing controls that meet all of the following requirements, as applicable:

I. Infrared sensors shall be equipped by the manufacturer, or fitted in the field by the installer, with lenses or shrouds to prevent them from being triggered by movement outside of the controlled area.

II. Ultrasonic sensors shall be tuned to reduce their sensitivity to prevent them from being triggered by movements outside of the controlled area.

III. All other sensors shall be installed and adjusted as necessary to prevent them from being triggered by movements outside of the controlled area.

e. Occupant sensing control zones, in offices greater than 250 square feet, shall be shown on the plans.

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x. To qualify for the PAF for an Institutional Tuning in Table 170.2-L, the tuned lighting system shall comply with all of the following requirements:
   a. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and
   b. The means of setting the limit is accessible only to authorized personnel; and
   c. The setting of the limit is verified by the acceptance test required by Section 160.5(e)1G; and
   d. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85 percent of full light output or full power draw.

xi. To qualify for the PAF for a demand responsive control in Table 170.2-L, the general lighting wattage receiving the PAF shall not be within the scope of Section 110.12(c) and a demand responsive control shall meet all of the following requirements:
   a. The controlled lighting shall be capable of being automatically reduced in response to a demand response signal; and
   b. General lighting shall be reduced in a manner consistent with the illuminance uniformity requirements of Section 160.5(b)4B.

xii. To qualify for the PAFs for clerestory fenestration, horizontal slats or light shelves in Table 170.2-L, the daylighting design shall meet the requirements in Section 170.2(b). The PAFs shall only apply to lighting in a primary or secondary sidelit daylit zone where continuous dimming daylighting controls meeting the requirements of Section 160.5(b)4D are installed.

TABLE 170.2-L—LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA	FACTOR
1. Daylight Continuous Dimming Plus OFF Control	Luminaires in skylit daylit zone or primary sidelit daylit zone	0.10
2. Occupant Sensing Controls in Office Spaces Larger Than 250 Square Feet	In open plan offices > 250 square feet: One sensor controlling an area that is: No larger than 125 square feet	0.30
	In open plan offices > 250 square feet: One sensor controlling an area that is: From 126 to 250 square feet	0.20
3. Institutional Tuning	Luminaires in nondaylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.10
	Luminaires in daylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.05
4. Demand Responsive Control	General lighting luminaires not in the scope of Section 110.12(c). Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF.	0.05
5. Clerestory Fenestration	Luminaires in daylit areas adjacent to the clerestory. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.05
6. Horizontal Slats	Luminaires in daylit areas adjacent to vertical fenestration with interior or exterior horizontal slats. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.05
7. Light Shelves	Luminaires in daylit areas adjacent to clerestory fenestration with interior or exterior light shelves. This PAF may be combined with the PAF for clerestory fenestration. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.	0.10

a. To qualify for any of the power adjustment factors in this table, the installation shall comply with the applicable requirements in Section 170.2(e)1Aii.
b. Only one PAF may be used for each qualifying luminaire unless combined.
c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF.

C. **Lighting wattage excluded.** The watts of the following indoor lighting applications may be excluded from Adjusted Indoor Lighting Power:
   i. Lighting installed by the manufacturer in walk-in coolers or freezers, vending machines and food preparation equipment.
   ii. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.
   iii. Exit way or egress illumination that is normally off and that is subject to the CBC.
   iv. Temporary lighting systems.
   v. Lighting systems in qualified historic buildings, as defined in the *California Historical Building Code* (Title 24, Part 8), are exempt from the lighting power density allowances if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other lighting systems in qualified historic buildings shall comply with the lighting power density allowances.

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vi. Lighting for signs shall comply with Section 170.2(e)7.

vii. Lighting in elevators where the lighting meets the requirements in Section 120.6(f).

viii. Lighting connected to a Life Safety Branch or Critical Branch, as specified in Section 517 of the *California Electrical Code*.

D. **Luminaire classification and power adjustment.**

i. Luminaire classification and power shall be determined in accordance with Section 160.5(b)1.

ii. Small Aperture Tunable-White and Dim-to-Warm Luminaires Lighting Power Adjustment. For qualifying small aperture tunable-white and dim-to-warm LED luminaires, the adjusted indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage by 0.75. Qualifying luminaires shall meet all of the following:

a. Small aperture. Qualifying luminaires with a luminaire aperture length longer than 18 inches shall have a luminaire aperture no wider than 4 inches. Qualifying luminaires with a luminaire aperture length of 18 inches or less shall have a luminaire aperture no wider than 8 inches.

b. Color changing. Qualifying tunable-white luminaires shall be capable of a color change greater than or equal to 2000 Kelvin correlated color temperature (CCT). Qualifying dim-to-warm luminaires shall be capable of color change greater than or equal to 500 Kelvin CCT.

c. Controls. Qualifying luminaires shall be connected to controls that allow color changing of the luminaires.

3. **Calculation of allowed indoor lighting power: general rules.**

A. The allowed indoor lighting power allotment for conditioned areas shall be calculated separately from the allowed lighting power allotment for unconditioned areas. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between conditioned and unconditioned area allotments.

B. The allowed indoor lighting power allotment shall be calculated separately from the allowed outdoor lighting power allotment. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between the separate indoor and outdoor allotments.

C. The allowed indoor lighting power allotment for general lighting shall be calculated as follows:

i. The Area Category Method, as described in Section 170.2(e)4A, shall be used for all common-use areas in the building. Under the Area Category Method, as described more fully in Section 170.2(e)4A, and subject to the adjustments listed there, the allowed indoor lighting power allotment for general lighting shall be calculated for each area in the building as follows:

a. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 170.2-M.

b. For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 170.2-M.

The allowed indoor lighting power allotment for general lighting for one area for which the Area Category Method was used may be increased up to the amount that the allowed indoor lighting power allotment for general lighting for another area using the Area Category Method, except that such increases and decreases shall not be made between conditioned and unconditioned space.

D. Additional lighting power allowances other than general lighting power allowances shall be restricted when using the Area Category Method. Additional lighting power allowances for display, decorative, wall display, floor display, or task, may not be increased as a result of, or otherwise traded off against, decreasing any other allotment.

4. **Calculation of allowed indoor lighting power: specific methodologies.** The allowed indoor lighting power for each common use primary function area shall be calculated using the following method.

A. Area Category Method. Requirements for using the Area Category Method include all of the following:

i. The Area Category Method shall be used only for primary function areas, as defined in Section 100.1, that are listed in Table 170.2-M. For primary function areas not listed, selection of a reasonably equivalent type shall be permitted.

ii. For purposes of compliance with Section 170.2(e)4A, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in Table 170.2-M.

iii. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a primary function area.

iv. The allowed indoor lighting power for each primary function area is the Lighting Power Density value in Table 170.2-M times the square feet of the primary function area. The total allowed indoor lighting power for the building is the sum of all allowed indoor lighting power for all areas in the building.

v. In addition to the allowed indoor lighting power calculated according to Sections 170.2(e)4Ai through iv, the building may add additional lighting power allowances for qualifying lighting systems as specified in the Qualifying Lighting Systems column in Table 170.2-M under the following conditions:

a. Only primary function areas having a lighting system as specified in the Qualifying Lighting Systems column in Table 170.2-M and in accordance with the corresponding footnote of the table shall qualify for the additional lighting power allowances; and

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b. The additional lighting power allowances shall be used only if the plans clearly identify all applicable task areas and the lighting equipment designed to illuminate these tasks; and

c. Tasks that are performed less than 2 hours per day or poor quality tasks that can be improved are not eligible for the additional lighting power allowances; and

d. The additional lighting power allowances shall not utilize any type of luminaires that are used for general lighting in the building; and

e. Reserved; and

f. The additional lighting power allowed is the smaller of:

I. the lighting power density listed in the "Allowed Additional Lighting LPD" column in Table 170.2-M, times the square feet of the primary function, or

II. the adjusted indoor lighting power of the applicable lighting; and

g. Floor displays shall not qualify for wall display allowances.

h. Qualifying wall lighting shall:

I. Be mounted within 10 feet of the wall having the wall display. When track lighting is used for wall display, and where portions of that lighting track are more than 10 feet from the wall and other portions are within 10 feet of the wall, portions of track more than 10 feet from the wall shall not be used for the wall display allowance; and

II. Be a lighting system type appropriate for wall lighting. Lighting systems appropriate for wall lighting are lighting track adjacent to the wall, wall-washer luminaires, luminaires behind a wall valance or wall cove or accent light. (Accent luminaires are adjustable or fixed luminaires providing directional display light.)

i. Mounting height shall be the luminaire mounting height measured from the finished floor to the bottom of the luminaire. If luminaires are mounted at different mounting heights within the same space, the average mounting height of the luminaires qualified for the additional lighting power allowances in Table 170.2-M can be used to establish the mounting height of the qualified luminaires for calculations of the additional lighting power allowances of the qualified luminaires.

TABLE 170.2-M—AREA CATEGORY METHOD—LIGHTING POWER DENSITY VALUES (WATTS/FT^2)

PRIMARY FUNCTION AREA	ALLOWED LIGHTING POWER DENSITY FOR GENERAL LIGHTING (W/ft^2)	ADDITIONAL LIGHTING POWER QUALIFIED LIGHTING SYSTEMS	ADDITIONAL LIGHTING POWER ADDITIONAL ALLOWANCE (W/ft^2, unless noted otherwise)
Storage	0.4	NA	NA
Conference, Multipurpose and Meeting Area	0.75	Display	0.25
	0.75	Wall display MH ≤ 10′6″	2 W/ft
	0.75	Wall display MH 10′7″to 14′	2.35 W/ft
	0.75	Wall display MH > 14′	2.66 W/ft
	0.75	Floor display & task MH ≤ 10′6″	0.30
	0.75	Floor display & task MH 10′7″to 14′	0.35
	0.75	Floor display & task MH > 14′	0.40
Copy Room	0.50	NA	NA
Corridor Area	0.40	Decorative/display	0.25
Dining Area Bar/Lounge and Fine Dining	0.45	Display	0.35
	0.45	Wall display MH ≤ 10′6″	1.25 W/ft
	0.45	Wall display MH 10′7″to 14′	1.5 W/ft
	0.45	Wall display MH > 14′	1.7 W/ft
	0.45	Floor display & task MH ≤ 10′6″	0.45
	0.45	Floor display & task MH 10′7″to 14′	0.52
	0.45	Floor display & task MH > 14′	0.60
	0.45	General lighting in the enclosed space of ceiling height > 10′	0.25
Dining Area Cafeteria/Fast Food	0.45	Display/decorative	0.25
Dining Area Family and Leisure	0.40	Display/decorative	0.25
Health Care / Assisted Living Nurse's Station	0.85	Tunable white or dim-to-warm[8]	0.10

TABLE 170.2-M—AREA CATEGORY METHOD—LIGHTING POWER DENSITY VALUES (WATTS/FT²)—continued

PRIMARY FUNCTION AREA		ALLOWED LIGHTING POWER DENSITY FOR GENERAL LIGHTING (W/ft²)	ADDITIONAL LIGHTING POWER QUALIFIED LIGHTING SYSTEMS	ADDITIONAL LIGHTING POWER ADDITIONAL ALLOWANCE (W/ft², unless noted otherwise)
Health Care/Assisted Living Physical Therapy Room		0.75	Tunable white or dim-to-warm[8]	0.10
Kitchen/Food Preparation Area		0.95	NA	NA
Electrical, Mechanical, Telephone Rooms		0.40	Detailed task work[1]	0.20
Exercise/Fitness Center and Gymnasium Area		0.50	NA	NA
Lobby, Main Entry		0.70	Display	0.25
		0.70	Wall Display MH ≤ 10′6″	3 W/ft
		0.70	Wall Display MH 10′7″ to 14′	3.5 W/ft
		0.70	Wall Display MH > 14′	4 W/ft
Locker Room		0.45	NA	NA
Lounge, Breakroom or Waiting Area		0.55	Display/decorative	0.25
Concourse and Atrium Area		0.60	Display/decorative	0.25
Office Area > 250 square feet		0.60	Decorative/display and portable lighting for office areas[5]	0.20
Office Area ≤ 250 square feet		0.65	Decorative/display and portable lighting for office areas[5]	0.20
Parking Garage Area	Parking Zone and Ramps	0.10	First ATM or ticket machine	100 W
Parking Garage Area	Parking Zone and Ramps	0.10	Additional ATM or ticket machine	50 W each
Parking Garage Area	Daylight Adaptation Zones[3]	1.00	NA	NA
Laundry Area		0.45	NA	NA
Restrooms		0.65	Display/decorative	0.35
Stairwell		0.60	Display/decorative	0.35
All other		0.40	NA	NA
Aging Eye/Low-vision[6] Lobby, Main Entry		0.85	Display/decorative	0.30
Aging Eye/Low-vision[6] Lobby, Main Entry		0.85	Transition lighting OFF at night[7]	0.95
Aging Eye/Low-vision[6] Stairwell		0.80	Display/decorative	0.30
Aging Eye/Low-vision[6] Corridor Area		0.70	Display/decorative	0.30
Aging Eye/Low-vision[6] Lounge/Waiting Area		0.80	Display/decorative	0.30
Aging Eye/Low-vision[6] Multipurpose Room		0.85	Display/decorative	0.30
Aging Eye/Low-vision[6] Dining		0.80	Display/decorative	0.30
Aging Eye/Low-vision[6] Restroom		1.00	Display/decorative	0.20

1. Detailed task work—Lighting provides the high level of visual acuity required for activities with close attention to small elements and/or extreme close-up work.
2. MH denotes the luminaire mounting height of the qualified lighting systems.
3. Daylight adaptation zones shall be no longer than 66 feet from the entrance to the parking garage.
4. Reserved.
5. Portable lighting in office areas includes under-shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor.
6. Aging Eye/Low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for either senior long-term care, adult day care, senior support and/or people with special visual needs.
7. Transition lighting OFF at night. Lighting power controlled by astronomical time clock or other control to shut off lighting at night. Additional LPD only applies to area within 30 feet of an exit. Not applicable to lighting in daylit zones.
8. Tunable white luminaires capable of color change greater than or equal to 2000K CCT, or dim-to-warm luminaires capable of color change greater than or equal to 500K CCT, connected to controls that allow color changing of the luminaires.

5. **Reserved.**

6. **Outdoor lighting.**

A. A multifamily or mixed occupancy outdoor lighting installation complies with this section if it meets the requirements in Subsections 170.2(e)6B and C, and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection 170.2(e)6D. The allowed outdoor lighting shall be calculated according to outdoor lighting zone in Title 24, Part 1, Section 10-114.

Exceptions to Section 170.2(e)6A: When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall not be required to comply with Section 170.2(e)6:

i. Temporary outdoor lighting.

ii. Lighting required and regulated by the Federal Aviation Administration and the Coast Guard.

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iii. Lighting for public streets, roadways, highways and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way owned or maintained by a local municipality or utility.

iv. Lighting for sports and athletic fields, and children's playgrounds.

v. Reserved.

vi. Lighting of public monuments.

vii. Lighting of signs complying with the requirements of Sections 160.5(d) and 170.2(e)7.

viii. Lighting of stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.

ix. Landscape lighting.

x. Reserved.

xi. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.

xii. Outdoor lighting systems for qualified historic buildings, as defined in the *California Historic Building Code* (Title 24, Part 8), if they consist solely of historic lighintg components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 170.2(e)6.

B. **Outdoor lighting power trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

i. Allowed lighting power determined according to Section 170.2(e)6Di for general hardscape lighting allowance may be traded to specific applications in Section 170.2(e)6Dii, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 170.2(e)6Dia.

ii. Allowed lighting power determined according to Section 170.2(e)2Dii for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 170.2(e)6Di.

iii. Trading off lighting power allowances between outdoor and indoor areas shall not be permitted.

C. **Calculation of actual lighting power.** The wattage of outdoor luminaires shall be determined in accordance with Section 160.5(b)1.

D. **Calculation of allowed lighting power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 170.2(e)2Di, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 170.2(e)6Dii.

i. **General hardscape lighting allowance**. Determine the general hardscape lighting power allowances as follows:

a. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s) and other improved area(s) that are illuminated. Public roadway(s) that are illuminated by a lighting system owned or maintained by the local municipality or utility shall not be included in the area calculations. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the Area Wattage Allowance (AWA) from Table 170.2-R for the appropriate lighting zone.

b. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from Table 170.2-R for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.

c. The general hardscape lighting allowance shall be the sum of the allowed watts determined from a and b above.

TABLE 170.2-R—GENERAL HARDSCAPE MULTIFAMILY LIGHTING POWER ALLOWANCE

TYPE OF POWER ALLOWANCE	LIGHTING ZONE 0[2]	LIGHTING ZONE 1[2]	LIGHTING ZONE 2[2]	LIGHTING ZONE 3[2]	LIGHTING ZONE 4[2]
Area Wattage Allowance (AWA)	No allowance[1]	0.026 W/ft^2	0.030 W/ft^2	0.038 W/ft^2	0.055 W/ft^2
Initial Wattage Allowance (IWA)	No allowance[1]	300 W	350 W	400 W	450 W

1. Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 160.5(c)1.
2. Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm—as mandated by local, state or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna—shall be allowed a 2.0 lighting power allowance multiplier.

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ii. **Additional lighting power allowance for specific applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with Table 170.2-S for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

TABLE 170.2-S—ADDITIONAL MULTIFAMILY LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.

LIGHTING APPLICATION	LIGHTING ZONE 0	LIGHTING ZONE 1	LIGHTING ZONE 2	LIGHTING ZONE 3	LIGHTING ZONE 4
PER APPLICATION: WATTAGE ALLOWANCE. Use all that apply as appropriate.					
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not applicable	9 watts	15 watts	19 watts	21 watts
Primary Entrances to Senior Care Facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not applicable	20 watts	40 watts	57 watts	60 watts
ATM Lighting. Allowance per ATM. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not applicable	100 watts for first ATM, 35 watts for each additional ATM.			
PER APPLICATION: WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 50 watts or less as determined in accordance with Section 160.5(b)1 and shall be post-top luminaires, lanterns, pendant luminaires or chandeliers.	Not applicable	No Allowance	0.007 W/ft²	0.013 W/ft²	0.019 W/ft²
PER APPLICATION: WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). Use as appropriate provided that none of the following specific applications shall be used for the same area.					
Building Façades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects. This allowance calculation shall not include portions of the building facades within 20 feet of residence bedroom windows.	Not applicable	No Allowance	0.100 W/ft²	0.170 W/ft²	0.225 W/ft²
Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not applicable	0.057 W/ft²	0.137 W/ft²	0.270 W/ft²	0.370 W/ft²
Student Pick-up/Drop-off Zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within two mounting heights of the student pick-up/drop-off zone.	Not applicable	No Allowance	0.056 W/ft²	0.200 W/ft²	No Allowance
Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within two mounting heights of the hardscape area of outdoor dining.	Not applicable	0.004 W/ft²	0.030 W/ft²	0.050 W/ft²	0.075 W/ft²
PER SITE: WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used as additional allowance for applicable illuminated hardscape area on the site.					
Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft²	0.005 W/ft²	0.010 W/ft²	No Allowance
Security Camera. This additional allowance is for the illuminated general hardscape area. This allowance shall apply when a security camera is installed within two mounting heights of the general hardscape area and mounted more than 10 feet away from a building.	Not applicable	No Allowance	0.018 W/ft²	0.018 W/ft²	0.018 W/ft²

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7. **Requirements for signs**. Section 170.2(e)7 applies to all internally illuminated and externally illuminated signs, unfiltered light emitting diodes (LEDs), and unfiltered neon, both indoor and outdoor. Each sign shall comply with either Subsection A or B, as applicable.

   A. **Maximum allowed lighting power.**

      i. For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 12 watts per square foot. For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power.

      ii. For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 2.3 watts per square foot. Only areas of an externally lighted sign that are illuminated without obstruction or interference, by one or more luminaires, shall be used.

      iii. Lighting for unfiltered light emitting diodes (LEDs) and unfiltered neon shall comply with Section 170.2(e)7B.

   B. **Alternate lighting sources.** The sign shall be equipped with one or more of the following light sources:

      i. Reserved.

      ii. Reserved.

      iii. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to the following:

         a. A minimum efficiency of 75 percent when the transformer or power supply rated output current is less than 50 mA; or

         b. A minimum efficiency of 68 percent when the transformer or power supply rated output current is 50 mA or greater.

      The ratio of the output wattage to the input wattage is at 100 percent tubing load.

      iv. Reserved.

      v. Light emitting diodes (LEDs) with a power supply having an efficiency of 80 percent or greater; or

      Exception to Section 170.2(e)7Bv: Single voltage external power supplies that are designed to convert 120 volt AC input into lower voltage DC or AC output, and have a nameplate output power less than or equal to 250 watts, shall comply with the applicable requirements of the Appliance Efficiency Regulations (Title 20).

      Exception 1 to Section 170.2(e)7: Unfiltered incandescent lamps that are not part of an electronic message center (EMC), an internally illuminated sign or an externally illuminated sign.

      Exception 2 to Section 170.2(e)7: Exit signs. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

      Exception 3 to Section 170.2(e)7: Traffic signs that meet the requirements of the Appliance Efficiency Regulations, Sections 1601(m), 1602, 1602.1, 1603, 1604(m), 1605, 1605.1(m), 1605.2(m), 1605.3(m), 1606, 1607, 1608, and 1609.

(f) **Photovoltaic requirements—three habitable stories or fewer**. All multifamily buildings up to three habitable stories shall have a newly installed photovoltaic (PV) system or newly installed PV modules meeting the minimum qualification requirements specified in Joint Appendix JA11. The annual electrical output of the PV system shall be no less than the smaller of a PV system size determined using Equation 170.2-C, or the total solar access roof area (SARA) multiplied by 18 for steep-sloped roofs or SARA multiplied by 14 for low-sloped roofs.

A. SARA includes the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports, and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.10.

B. SARA does NOT include:

   i. Any roof area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation, accounting for shading obstructions, by the total annual solar insolation if the same areas were unshaded by obstructions. For steep-sloped roofs, only shading from existing permanent natural or manmade obstructions that are external to the dwelling, including but not limited to trees, hills and adjacent structures, shall be considered for annual solar access calculations. For low slope roofs, all obstructions including those that are external to the dwelling unit, and obstructions that are part of the building design and elevation features, shall be considered for the annual solar access calculations.

   ii. Occupied roof areas as specified by CBC Section 503.1.4.

   iii. Roof area that is otherwise not available due to compliance with:

      a. Other state building code requirements, or

      b. Local building code requirements if local building code requirements are confirmed by the Executive Director.

EQUATION 170.2-C—ANNUAL PHOTOVOLTAIC ELECTRICAL OUTPUT

$kW_{PV} = (CFA \times A)/1000 + N_{DU} \times B)$

where:

kW_{PV} = kW_{dc} size of the PV system.

CFA = Conditioned floor area.

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N_{DU} = Number of dwelling units.

A = CFA adjustment factor from Table 170.2-T.

B = Dwelling unit adjustment factor from Table 170.2-T.

Exception 1 to Section 170.2(f): For steep slope roofs, SARA shall not consider roof areas with a northerly azimuth that lies between 300 degrees and 90 degrees from true north. No PV system is required if the SARA is less than 80 contiguous square feet.

Exception 2 to Section 170.2(f): No PV system is required when the minimum PV system size specified by Section 170.2(f) is less than 4 kW_{dc}.

Exception 3 to Section 170.2(f): Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules and components and supports and attachments to the roof structure, to meet the requirements of American Society of Civil Engineers (ASCE) Standard 7-16, Chapter 7, Snow Loads.

Exception 4 to Section 170.2(f): For buildings that are approved by the local planning department prior to January 1, 2020 with mandatory conditions of approval:

a. Shading from roof designs and configurations for steep slope roofs shall be considered for the annual solar access calculations; and

b. Roof areas that are not allowed to have PVs by the mandatory conditions of approval shall not be considered in determining the SARA.

Exception 5 to Section 170.2(f): PV system sizes determined using Equation 170.2-C may be reduced by 25 percent if installed in conjunction with a BESS. The BESS shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum cycling capacity of 7.5 kWh as defined in Joint Appendix JA12.

TABLE 170.2-T—CFA AND DWELLING UNIT ADJUSTMENT FACTORS

CLIMATE ZONE	A—CFA	B—DWELLING UNITS
1	0.793	1.27
2	0.621	1.22
3	0.628	1.12
4	0.586	1.21
5	0.585	1.06
6	0.594	1.23
7	0.572	1.15
8	0.586	1.37
9	0.613	1.36
10	0.627	1.41
11	0.836	1.44
12	0.613	1.40
13	0.894	1.51
14	0.741	1.26
15	1.56	1.47
16	0.59	1.22

(g) **Photovoltaic requirements—more than three habitable stories.** All newly constructed building types specified in Table 170.2-U, or mixed occupancy buildings where at least 80 percent of the floor area of the building serves one or more of these building types, shall have a newly installed photovoltaic (PV) system meeting the minimum qualification requirements of Reference Joint Appendix JA11. The PV capacity in kW_{dc} shall not be less than the smaller of the minimum rated PV system capacity determined by Equation 170.2-D, or the total of all available solar access roof areas (SARA) multiplied by 18 for steep-sloped roofs or multiplied by 14 for low-sloped roofs. In mixed occupancy buildings, the minimum rated PV system capacity for the building shall be determined by applying Equation 170.2-D to the conditioned floor area of each of the listed building types and summing the capacities determined for each.

1. SARA include the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.10.
2. SARA does not include:
   A. Any area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation (accounting for shading obstructions) by the total annual solar insolation if the same areas were unshaded by those obstructions. For all roofs, all obstructions including those that are external to the building,

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and obstructions that are part of the building design and elevation features, may be considered for the annual solar access calculations.

B. Occupied roofs as specified by CBC Section 503.1.4.

C. Roof area that is otherwise not available due to compliance with:

i. Other state building code requirements, or

ii. Local building code requirements if the local building code requirements are confirmed by the Executive Director.

EQUATION 170.2-D—PHOTOVOLTAIC DIRECT CURRENT CAPACITY

$kW_{PVdc} = (CFA \times A)/1000$

where:

kW_{PVdc} = Minimum rated PV system capacity in kW.

CFA = Conditioned floor area in square feet.

A = PV capacity factor in W/square foot as specified in Table 170.2-U for the building type.

Exception 1 to Section 170.2(g): No PV system is required where the total of all available SARA is less than 3 percent of the conditioned floor area.

Exception 2 to Section 170.2(g): No PV system is required where the required PV system capacity is less than 4 kW_{dc}.

Exception 3 to Section 170.2(g): No PV system is required if the SARA contains less than 80 contiguous square feet.

Exception 4 to Section 170.2(g): Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules, components, supports and attachments to the roof structure, to meet ASCE 7-16, Chapter 7, Snow Loads.

Exception 5 to Section 170.2(g): Multifamily buildings with more than three habitable stories in areas where a load-serving entity does not provide a program where PV generation is compensated through virtual energy bill credits. This exception does not apply where the Commission has approved a community solar program for showing compliance as specified in Title 24, Part 1, Section 10-115, or where a load-serving entity provides a program where PV generation is compensated through virtual energy bill credits for occupants of nonresidential and hotel/motel tenant spaces to receive energy bill benefits from netting of energy generation and consumption.

TABLE 170.2-U – PV CAPACITY FACTORS **(W/ft² of conditioned floor area)**

BUILDING TYPE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Event & Exhibit	3.48	4.28	3.66	4.32	3.77	4.05	4.28	4.83	4.63	4.80	5.04	4.44	4.95	4.36	5.48	3.38
Library	0.39	3.23	2.59	3.25	2.48	2.74	3.04	3.49	3.32	3.69	3.79	3.32	3.79	3.37	4.49	2.84
Hotel/Motel	1.69	1.90	1.66	1.97	1.69	1.87	1.94	2.22	2.09	2.20	2.30	2.05	2.30	2.02	2.72	1.73
Office, Financial Institution, Unleased Tenant Space, Medical Office Building/Clinic	2.59	3.13	2.59	3.13	2.59	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.80	2.59
Restaurant	8.55	9.32	8.16	9.65	8.21	8.73	9.11	10.18	9.75	10.28	10.85	9.73	10.69	9.73	12.25	8.47
Retail, Grocery	3.14	3.49	3.01	3.61	3.05	3.27	3.45	3.83	3.65	3.81	4.09	3.64	3.99	3.71	4.60	3.21
School	1.27	1.63	1.27	1.63	1.27	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	2.46	1.27
Warehouse	0.39	0.44	0.39	0.44	0.39	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.58	0.39
Religious Worship	4.25	4.65	3.49	4.52	3.72	4.29	4.64	5.89	5.30	5.67	5.89	4.99	5.78	4.63	7.57	3.90
Sports & Recreation	2.47	1.97	1.54	2.03	1.60	1.84	1.98	2.63	2.47	2.60	2.75	2.20	2.72	2.15	4.03	1.81
Multifamily > 3 stories	1.82	2.21	1.82	2.21	1.82	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.77	1.82

(h) **Battery energy storage system (BESS) requirements—more than three habitable stories.** All buildings that are required by Section 170.2(g) to have a PV system shall also have a BESS meeting the minimum qualification requirements of Reference Joint Appendix JA12. The rated energy capacity shall be not less than the Minimum Rated Useable Energy Capacity determined by Equation 170.2-E, or by Equation 170.2-F if SARA was used to determine the PV capacity in Section 170.2-D, and the rated power capacity shall be not less than the Minimum Power Capacity determined by Equation 170.2-G. In mixed occupancy buildings, the total battery system capacity for the building shall be determined by applying the Minimum Rated Usable Energy Capacity to each of the listed building types and summing the capacities determined for each.

EQUATION 170.2-E—BATTERY ENERGY STORAGE SYSTEM MINIMUM RATED USABLE ENERGY CAPACITY

$kWh_{batt} = k((CFA \times B)/(1000 \times C^{0.5}))$

EQUATION 170.2-F—BATTERY ENERGY STORAGE SYSTEM MINIMUM RATED USABLE ENERGY CAPACITY, SARA-ADJUSTED

$kWh_{batt} = k((CFA \times B)/(1000 \times C^{0.5})) \times (kWP_{Vdc,SARA}/kWP_{Vdc})$

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where:

kWh_{batt} = Minimum Rated Usable Energy Capacity of the BESS in kWh.

kW_{PVdc} = Minimum Rated PV System Capacity in kW from Equation 170.2D.

$kW_{PVdc, SARA}$ = Minimum Rated PV System Capacity in kW from the SARA calculation.

CFA = Conditioned floor area that is subject to the PV system requirements of Section 170.2(g) in square feet.

B = BESS Capacity Factor in Wh/square foot as specified in Table 170.2-V for the building type.

C = Rated single charge-discharge cycle AC to AC (round-trip) efficiency of the BESS.

EQUATION 170.2-G—BATTERY *ENERGY STORAGE SYSTEM MINIMUM* RATED POWER CAPACITY

$kW_{batt} = kW_{batt}/4$

where:

kW_{batt} = Minimum Rated Power Capacity of the BESS in kW_{dc}.

kWh_{batt} = Minimum Rated Usable Energy Capacity of the BESS in kWh.

Exception 1 to Section 170.2(h): No BESS is required if the installed PV system capacity is less than 15 percent of the capacity determined by Equation 170.2-D.

Exception 2 to Section 170.2(h): No BESS is required in buildings with BESS requirements with less than 10 kWh minimum rated usable energy capacity.

TABLE *170.2-V—BESS CAPACITY FACTORS (Wh/ft² of conditioned floor area)*

BUILDING TYPE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Event & Exhibit	1.82	1.95	1.74	2.12	1.91	2.13	2.24	2.30	2.36	2.47	2.62	2.16	2.64	2.68	3.22	1.89
Library	0.37	7.17	5.97	6.75	5.64	6.08	6.19	7.13	7.18	7.56	7.17	6.93	6.88	6.81	7.93	6.40
Hotel/Motel	0.86	0.84	0.77	0.92	0.81	0.89	0.90	1.01	1.00	1.11	1.14	0.96	1.18	1.18	1.49	0.85
Office, Financial Institution, Unleased Tenant Space, Medical Office Building/Clinic	NR[1]	5.26	4.35	5.26	4.35	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	6.39	4.35
Restaurant	4.36	4.11	3.78	4.37	3.89	4.02	4.11	4.49	4.47	4.82	5.05	4.43	5.05	5.24	6.23	4.11
Retail, Grocery	1.89	1.82	1.71	1.82	1.72	1.80	1.76	1.92	1.97	2.05	2.22	1.95	2.16	2.29	2.66	1.91
School	NR[1]	3.05	2.38	3.05	2.38	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	4.60	2.38
Warehouse	NR[1]	0.41	0.37	0.41	0.37	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.54	0.37
Religious Worship	2.21	2.25	1.74	2.42	2.08	2.75	2.94	3.37	3.17	3.37	3.58	2.72	3.62	3.21	4.89	2.37
Sports & Recreation	1.26	0.98	0.76	1.14	0.86	1.20	1.23	1.57	1.53	1.65	1.83	1.27	1.86	1.57	3.02	1.13
Multifamily > 3 stories	1.88	2.27	1.88	2.27	1.88	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.85	1.88

1. NR = Not Required.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8 and 25943, *Public Resources Code*.

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SUBCHAPTER

12

MULTIFAMILY BUILDINGS—ADDITIONS, ALTERATIONS AND REPAIRS TO EXISTING MULTIFAMILY BUILDINGS

SECTION 180.0—GENERAL

Additions, alterations and repairs to existing attached dwelling units and common use areas in multifamily buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs shall meet the requirements specified in Sections 100.0 through 110.10, 160.1, and 160.3 through 170.2 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 180.1(b) (for additions) or 180.2(c) (for alterations), or the prescriptive compliance approach in Section 180.1(a) (for additions) or 180.2(b) (for alterations), for the climate zone in which the building is located. Climate zones are shown in Figure 100.1-A.

Covered process requirements for additions, alterations and repairs to existing multifamily buildings are specified in Section 141.1.

Nonresidential occupancies in mixed occupancy buildings shall comply with nonresidential requirements in Sections 120.0 through 141.1.

NOTE: For alterations that change the occupancy classification of the building, the requirements specified in Section 180.2 apply to the occupancy after the alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 180.1—ADDITIONS

Additions to existing multifamily buildings shall meet the applicable requirements of Sections 110.0 through 110.9; Sections 160.0, 160.1, and 160.2(c) and (d); Sections 160.3 through 160.7; and either Section 180.1(a) or 180.1(b).

Exception 2 to Section 180.1: Additions of 300 square feet or less are not required to comply with the roofing product requirements of Section 170.2(a)1A.

Exception 3 to Section 180.1: Existing inaccessible piping shall not require insulation as defined under Section 160.4(e).

Exception 4 to Section 180.1: Space-conditioning system. When heating or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Part 6. The heating system capacity must be adequate to meet the minimum requirements of CBC Section 1204.1.

Exception 5 to Section 180.1: Space-conditioning system ducts. When any length of ducts are extended from an existing duct system to serve the addition, the existing duct system and the extended ducts shall meet the applicable requirements specified in Sections 180.2(b)2Ai and 180.2(b)2Aii.

Exception 6 to Section 180.1: Photovoltaic and BESS, as specified in Sections 170.2(f) through 170.2(h), are not required for additions.

Exception 7 to Section 180.1: Dwelling unit space heating system. New or replacement space heating systems serving an addition may be a heat pump or gas heating system.

(a) **Prescriptive approach.** The envelope and lighting of the addition; any newly installed space-conditioning or ventilation system, electrical power distribution system, or water-heating system; any addition to an outdoor lighting system; and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110.0 through 110.12; 160.0, 160.1, and 160.2(c) and (d); and 160.3 through 170.2.

1. **Envelope.**
   - A. Additions that are greater than 700 square feet shall meet the requirements of Section 170.2(a), with the following modifications:
     - i. Framed walls extension. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing.
     - ii. The maximum allowed fenestration area shall be the greater of 175 square feet or 20 percent of the addition floor area.
     - iii. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing shall be installed and continuous insulation is not required.
     - iv. Additions that consist of the conversion of existing spaces from unconditioned to conditioned space shall not be required to perform the air sealing part of QII when the existing air barrier is not being removed or replaced.
   - B. Additions that are 700 square feet or less shall meet the requirements of Section 170.2(a), with the following modifications.
     - i. Roof and ceiling insulation in a ventilated attic shall meet one of the following requirements:
       - a. In Climate Zones 1, 2, 4, and 8 through 16, achieve an overall assembly *U*-factor not exceeding 0.025. In wood framed assemblies, compliance with *U*-factors may be demonstrated by installing insulation with an *R*-value of R-38 or greater.

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b. In Climate Zones 3 and 5 through 7, achieve an overall assembly *U*-factor not exceeding 0.031. In wood framed assemblies, compliance with *U*-factors may be demonstrated by installing insulation with an *R*-value of R-30 or greater.

ii. Radiant barrier. For buildings three habitable stories or less, radiant barriers shall be installed in attics with exposed attic deck undersides in Climate Zones 2–15.

iii. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing; and

iv. Fenestration products must meet the *U*-factor, RSGHC and VT requirements of Table 180.2-B.

v. Quality insulation installation (QII) requirements of Section 170.2(a)6 do not apply.

Exception to Section 180.1(a)1B: Insulation in an enclosed rafter ceiling shall meet the requirements of Section 160.1(a).

Exception to Section 180.1(a)1: Additions that increase the area of the roof by 2,000 square feet or less are not required to comply with the solar ready requirements of Section 160.8.

2. **Mechanical ventilation for indoor air quality.** Additions to existing buildings shall comply with Section 160.2 subject to the requirements specified in Subsections A and B below. When field verification and diagnostic testing are required by Section 180.1(a)2, buildings with three habitable stories or fewer shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

Exception to Section 180.1(a)2: A dwelling unit air leakage test is not required for additions.

A. **Whole-dwelling unit mechanical ventilation**.

i. Dwelling units that meet the conditions in Subsection a or b below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 160.2(b)2Aiv or 160.2(b)2Av.

a. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1,000 square feet.

b. Junior accessory dwelling units (JADU) that are additions to an existing building.

ii. Additions to an existing dwelling unit that increase conditioned floor area by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av, as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprising the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

Exception to Section 180.1(a)2Aii: Mechanical ventilation systems in additions shall be supply, balanced or the existing ventilation type.

iii. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

B. **Local mechanical exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in Sections 160.2(b)2Avi and 160.2(b)2B.

3. **Water heater.** When additional water-heating equipment is installed to serve a dwelling unit as part of the addition, one of the following types of water heaters shall be installed:

A. A water-heating system that meets the requirements of Section 170.2(d); or

B. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item A above.

(b) **Performance approach.** Performance calculations shall meet the requirements of Sections 170.0 through 170.2(a), pursuant to the applicable requirements in Items 1, 2 and 3 below.

1. **For additions alone.** The addition complies if the addition alone meets the energy budgets expressed in terms of long-term system cost (LSC) energy.

2. **Existing plus alteration plus addition.** The standard design for existing plus alteration plus addition energy use is the combination of the existing building's unaltered components to remain; existing building altered components that are the more efficient, in LSC energy, of either the existing conditions or the requirements of Section 180.2(c); plus the proposed addition's energy use meeting the requirements of Section 180.1(a). The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered components' energy features, plus the proposed energy features of the addition.

Exception to Section 180.1(b)2: Existing structures with a minimum R-11 insulation in framed walls showing compliance with Section 180.1(b) are not required to show compliance with Section 160.1(b).

3. **Mechanical ventilation for indoor air quality**. Additions to existing buildings shall comply with Section 160.2 subject to the requirements specified in Subsections A and B below. When field verification and diagnostic testing are required by Section 180.1(b)3, buildings with three habitable stories or fewer shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

A. **Whole-dwelling unit mechanical ventilation**.

i. Dwelling units that meet the conditions in Subsection a or b below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 160.2(b)2Aiv or 160.2(b)2Av.

a. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

b. Junior accessory dwelling units (JADU) that are additions to an existing building.

ii. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprising the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

iii. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

B. **Local mechanical exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in Sections 160.2(b)2Avi and 160.2(b)2B.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 180.2—ALTERATIONS

Alterations to components of existing multifamily buildings, including alterations made in conjunction with a change in building occupancy to a multifamily occupancy, shall meet Item (a), and either Item (b) or (c) below:

Exception 1 to Section 180.2: When heating, cooling or service water heating for an alteration is provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 110.10; Sections 160.0 through 160.7; and Section 170.2(c) or 170.2(d).

Exception 2 to Section 180.2: When existing heating, cooling or service water-heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 110.10; Sections 160.0 through 160.7; and Section 170.2(c) or 170.2(d).

Exception 3 to Section 180.2: Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply with Section 170.2(b)4E. Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of Section 170.2(b)4E.

Exception 4 to Section 180.2: The requirements of Section 160.3(a)2H shall not apply to alterations of space-conditioning systems or components.

(a) **Mandatory requirements.** Altered components in a multifamily building shall meet the minimum requirements in this section.

1. **Roof/ceiling insulation.** The opaque portions of the roof/ceiling that separate conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Section 180.2(b)1B.
2. **Wall insulation.** For the altered opaque portion of walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items A through D below:
   A. **Metal building.** A minimum of R-13 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.113.
   B. **Metal framed.** A minimum of R-13 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.217.
   C. **Wood framed and others.** A minimum of R-11 insulation between framing members, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.110.
   D. **Spandrel panels and curtain walls.** A minimum of R-4, or the area-weighted average *U*-factor of the wall assembly shall not exceed U-0.280.

   Exception to Section 180.2(a)2: Light and heavy mass walls.
3. **Floor insulation.** For the altered portion of raised floors that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items A and B below:
   A. **Raised framed floors.** A minimum of R-11 insulation between framing members, or the area-weighted average *U*-factor of the floor assembly shall not exceed U-0.071.
   B. **Raised mass floors.** A minimum of R-6 insulation, or the area-weighted average *U*-factor of the floor assembly shall not exceed U-0.111.

(b) **Prescriptive approach.** The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110.0 through 110.9 and all applicable requirements of Sections 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c) and 160.5; and

1. **Envelope.**

A. **Roof alterations**. Existing roofs being replaced, recovered or recoated of a multifamily building shall meet the requirements of Section 110.8(i). For roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, being altered, the requirements of i through iii below apply:

i. Low-sloped roofs in Climate Zones 2, 4, and 6 through 15 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75.

Exception to Section 180.2(b)1Ai: The aged solar reflectance requirement can be met by using insulation at the roof deck specified in Table 180.2-A.

TABLE 180.2-A—ROOF/CEILING INSULATION TRADEOFF FOR LOW-SLOPED AGED SOLAR REFLECTANCE

MINIMUM AGED SOLAR REFLECTANCE	ROOF DECK CONTINUOUS INSULATION *R*-VALUE (Climate Zones 6–7)	ROOF DECK CONTINUOUS INSULATION *R*-VALUE (Climate Zones 2, 4, 8–15)
0.60	2	16
0.55	4	18
0.50	6	20
0.45	8	22
No requirement	10	24

ii. Steep-sloped roofs in Climate Zones 4 and 8 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

Exception to Section 180.2(b)1Aii: The following shall be considered equivalent to Subsection ii:

a. Buildings with ceiling assemblies with a *U*-factor lower than or equal to 0.025 or that are insulated with at least R-38 ceiling insulation in an attic; or

b. Buildings with a radiant barrier in the attic, where the radiant barrier is not installed directly above spaced sheathing, meeting the requirements of Section 170.2(a)1C; or

c. Buildings that have no ducts in the attic in Climate Zones 2, 4, 9, 10, 12 and 14; or

d. Buildings with R-2 or greater continuous insulation above or below the roof deck.

Exception 1 to Sections 180.2(b)1Ai and ii: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels is not required to meet the minimum requirements for solar reflectance, thermal emittance or SRI.

Exception 2 to Sections 180.2(b)1Ai and ii: Roof constructions with a weight of at least 25 lb/ft^2 are not required to meet the minimum requirements for solar reflectance, thermal emittance or SRI.

iii. For low-sloped roofs, the area of the roof recover or roof replacement shall be insulated to R-14 continuous insulation or a *U*-factor of 0.039 in Climate Zones 1, 2, 4, and 8 through 16.

Exception 1 to Section 180.2(b)1Aiii: Roof recovers with new R-10 insulation added above deck do not need to be insulated to meet R-14.

Exception 2 to Section 180.2(b)1Aiii: When existing mechanical equipment located on the roof will not be disconnected and lifted, insulation added may be limited to the greater of R-10 or the maximum installed thickness that will allow the distance between the height of the roof membrane surface to the top of the base flashing to remain in accordance with the manufacturer's instructions.

Exception 3 to Section 180.2(b)1Aiii: At the drains and other low points, tapered insulation with a thermal resistance less than R-14 may be used, provided that insulation thickness is increased at the high points of the roof so that the average thermal resistance equals or exceeds R-14.

Exception 4 to Section 180.2(b)1Aiii: The area of the roof recoat is not required to be insulated.

B. **Roof/ceiling insulation**.

i. **Attic roof**. Vented attics shall meet the following:

a. In Climate Zones 1 through 4 and 8 through 16, insulation shall be installed to achieve a weighted *U*-factor of 0.020 or insulation installed at the ceiling level shall result in an installed thermal resistance of R-49 or greater for the insulation alone; and

Exception to Section 180.2(b)1Bia: In Climate Zones 1, 3, 4 and 9, dwelling units with at least R-19 existing insulation installed at the ceiling level.

b. In Climate Zones 2 and 11 through 16, air seal all accessible areas of the ceiling plane between the attic and the conditioned space in accordance with Section 110.7; and

Exception 1 to Section 180.2(b)1Bib: Dwelling units with at least R-19 existing insulation installed at the ceiling level.

Exception 2 to Section 180.2(b)1Bib: Dwelling units with atmospherically vented space heating or water-heating combustion appliances located inside the pressure boundary of the dwelling unit.

c. In Climate Zones 1 through 4 and 8 through 16, recessed downlight luminaires in the ceiling shall be covered with insulation to the same depth as the rest of the ceiling. Luminaires not rated for insulation contact must be replaced or fitted with a fireproof cover that allows for insulation to be installed directly over the cover; and

Exception to Section 180.2(b)1Bic: In Climate Zones 1 through 4 and 8 through 10, dwelling units with at least R-19 existing insulation installed at the ceiling level.

d. Attic ventilation shall comply with the *California Building Code* requirements.

Exception 1 to Section 180.2(b)1Bi: Dwelling units with at least R-38 existing insulation installed at the ceiling level.

Exception 2 to Section 180.2(b)1Bi: Dwelling units where the alteration would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

Exception 3 to Section 180.2(b)1Bi: Dwelling units with knob and tube wiring located in the vented attic.

Exception 4 to Section 180.2(b)1Bi: Where the accessible space in the attic is not large enough to accommodate the required *R*-value, the entire accessible space shall be filled with insulation, provided such installation does not violate Section 806.3 of Title 24, Part 2.5.

Exception 5 to Section 180.2(b)1Bi: Where the attic space above the altered dwelling unit is shared with other dwelling units and the requirements of Section 180.2(b)1Bi are not triggered for the other dwelling units.

C. Fenestration alterations other than repair shall meet the requirements of Items i and ii below:

NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs. In these cases, Section 180.2(b) requires that the replacement be at least equivalent to the original in performance.

i. Fenestration installed to replace existing fenestration of the same total area shall meet either a or b:

a. The maximum *U*-factor, RSHGC and VT requirements of Table 180.2-B, or

b. The area-weighted *U*-factor and RSHGC of Table 170.2-A.

Exception 1 to Section 180.2(b)1Ci: In an alteration, where 150 square feet or less of the entire building's vertical fenestration is replaced, RSHGC and VT requirements of Table 180.2-B shall not apply.

ii. Alterations that add vertical fenestration and skylight area shall meet the total fenestration area requirements of Section 170.2(a)3 and the RSHGC and VT requirements of Table 180.2-B.

Exception 1 to Section 180.2(b)1Cii: Alterations that add vertical fenestration area of up to 50 square feet shall not be required to meet the total fenestration area requirements of Sections 170.2(a)3, nor the RSHGC and VT requirements of Table 180.2-B.

Exception 2 to Section 180.2(b)1Cii: Alterations that add up to 16 square feet of new skylight area per dwelling unit with a maximum *U*-factor of 0.55 and a maximum RSHGC of 0.30 shall not be required to meet the total fenestration area requirements of Section 170.2(a)3.

D. **Exterior doors.** Alterations that add exterior door area shall meet the *U*-factor requirement of Section 170.2(a)4.

TABLE 180.2-B—ALTERED FENESTRATION MAXIMUM *U*-FACTOR AND MAXIMUM SHGC AND RSHGC, MINIMUM VT

BUILDING TYPE	FEATURE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Curtainwall/Storefront/ Window Wall[1]	*U*-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
Curtainwall/Storefront/ Window Wall[1]	RSHGC	NR	0.26	NR	0.26	NR	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	NR
Curtainwall/Storefront/ Window Wall[1]	VT[2]	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
NAFS 2017 Performance Class AW Window – Fixed	*U*-factor	0.38	0.38	0.38	0.38	0.38	0.47	0.47	0.41	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38
NAFS 2017 Performance Class AW Window – Fixed	RSHGC	NR	0.25	NR	0.25	NR	0.31	0.31	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.25	NR
NAFS 2017 Performance Class AW Window – Fixed	VT[2]	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
NAFS 2017 Performance Class AW Window – Operable	*U*-factor	0.43	0.43	0.43	0.43	0.43	0.47	0.47	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
NAFS 2017 Performance Class AW Window – Operable	RSHGC	NR	0.24	NR	0.24	NR	0.31	0.31	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR
NAFS 2017 Performance Class AW Window – Operable	VT[2]	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37

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TABLE 180.2-B—ALTERED FENESTRATION MAXIMUM *U*-FACTOR AND MAXIMUM SHGC AND RSHGC, MINIMUM VT—continued

BUILDING TYPE	FEATURE	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
All Other Windows and Glazed Doors	*U*-factor	0.28	0.30	0.28	0.28	0.28	0.30	0.34	0.30	0.30	0.30	0.28	0.30	0.28	0.28	0.30	0.28
All Other Windows and Glazed Doors	RSHGC	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
Skylights	*U*-factor	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Skylights	SHGC	NA	0.25	NA	0.25	NA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	NA
Skylights, Serving Common Areas	VT[2]	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49

1. Requirements apply to glazed doors included in the curtain wall/storefront construction assembly.
2. Minimum VT requirements for fenestration other than skylights do not apply to multifamily buildings three habitable stories or fewer.

2. **Space-conditioning systems**.

A. Space-conditioning systems serving dwelling units.

i. **Entirely new or complete replacement space-conditioning systems** installed as part of an alteration shall include all the system heating or cooling equipment, including but not limited to: condensing unit, cooling or heating coil, and air handler for split systems; or complete replacement of a packaged unit; plus entirely new or replacement duct system [Section 180.2(b)2Aiib]. Entirely new or complete replacement space-conditioning systems shall meet the requirements of Sections 160.2(a)1, 160.3(a)1, 160.3(b)1 through 3, 160.3(b)5, 160.3(b)6, 160.3(c)1, 170.2(c)3B and 180.2(b)2Av, and Table 180.2-C.

ii. **Altered duct systems—duct sealing:** In all climate zones, when more than 25 feet of new or replacement space-conditioning system ducts are installed, the ducts shall comply with the applicable requirements of Subsections a and b below. New ducts located in unconditioned space shall meet the applicable requirements of Sections 160.3(b)5A through J and the duct insulation requirements of Table 180.2-C, and

a. The altered duct system, regardless of location, shall be sealed as confirmed through field verification and diagnostic testing in accordance with all applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1, utilizing the leakage compliance criteria specified in Subsection I or II below.

TABLE 180.2-C—DUCT INSULATION *R*-VALUE

Climate Zone	3, 5 through 7	1, 2, 4, 8 through 16
Duct *R*-Value	R-6	R-8

I. Entirely new or complete replacement duct system. If the new ducts form an entirely new or complete replacement duct system directly connected to the air handler, the duct system shall meet one of the following requirements:

A. The total leakage of the duct system shall not exceed 12 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or

B. The duct system leakage to outside shall not exceed 6 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

Entirely new or complete replacement duct systems installed as part of an alteration are constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air handler, coil, plenums and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

Entirely new or complete replacement duct systems shall also conform to the requirements of Sections 160.2(a)1 and 160.3(b)5L. If the air handler and ducts are located within a vented attic, the requirements of Section 180.2(b)1Bi shall also be met.

II. Extension of an existing duct system. If the new ducts are an extension of an existing duct system serving multifamily dwellings, the combined new and existing duct system shall meet one of the following requirements:

A. The measured duct leakage shall be equal to or less than 15 percent of air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

B. The measured duct leakage to outside shall be equal to or less than 10 percent of air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

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C. If it is not possible to meet the duct sealing requirements of either Section 180.2(b)2AiicI or II then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified ECC-Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

Exception to Section 180.2(b)2AiiaII: duct sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

Exception 1 to 180.2(b)2Aii: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

iii. **Altered space-conditioning system—duct sealing.** In all climate zones, when a space-conditioning system serving a multifamily dwelling is altered by the installation or replacement of space-conditioning system equipment, including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil, the duct system that is connected to the altered space-conditioning system equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1 and the leakage compliance criteria specified in Subsection a, b or c below.

a. The measured duct leakage shall be equal to or less than 15 percent of air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

b. The measured duct leakage to outside shall be equal to or less than 10 percent of air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

c. If it is not possible to meet the duct sealing requirements of either Section 180.2(b)2Aiiia or b, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified ECC-Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

Exception 1 to Section 180.2(b)2Aiii: **duct sealing.** Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in Reference Residential Appendix RA3.1.

Exception 2 to Section 180.2(b)2Aiii: duct sealing. Duct systems with less than 40 linear feet as determined by visual inspection.

Exception 3 to Section 180.2(b)2Aiii: duct sealing. Existing duct systems constructed, insulated or sealed with asbestos.

Exception 4 to Section 180.2(b)2Aiii: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

iv. **Altered space-conditioning system mechanical cooling.** When a space-conditioning system is an air conditioner or heat pump that is altered by the installation or replacement of refrigerant-containing system components such as the compressor, condensing coil, evaporator coil, refrigerant metering device or refrigerant piping, the altered system shall comply with the following requirements:

a. All thermostats associated with the system shall be replaced with setback thermostats meeting the requirements of Section 110.2(c).

b. In Climate Zones 2 and 8 through 15, air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted package systems, small duct high velocity air systems, and minisplit systems, shall comply with Subsections I and II, unless the system is of a type that cannot be verified using the specified procedures. Systems that cannot comply with the requirements of Section 180.2(b)2Aivb shall comply with Section 180.2(b)2Aivc.

Exception to Section 180.2(b)2Aivb: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with the minimum system airflow rate requirement in Section 180.2(b)2AivbI, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

I. The minimum system airflow rate shall comply with the applicable Subsection A or B below as confirmed through field verification and diagnostic testing in accordance with the procedures specified in Reference Residential Appendix Section RA3.3 or an approved alternative procedure as specified in Section RA1.

A. Small duct high velocity systems shall demonstrate a minimum system airflow rate greater than or equal to 250 cfm per ton of nominal cooling capacity; or

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B. All other air-cooled air conditioner or air-source heat pump systems shall demonstrate a minimum system airflow rate greater than or equal to 300 cfm per ton of nominal cooling capacity.

Exception 1 to Section 180.2(b)2AivbI: Systems unable to comply with the minimum airflow rate requirement shall demonstrate compliance using the procedures in Section RA3.3.3.1.5, and the system's thermostat shall conform to the specifications in Section 110.12.

Exception 2 to Section 180.2(b)2AivbI: Entirely new or complete replacement space-conditioning systems, as specified by Section 180.2(b)2Ai, without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in Table 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 160.2(a)1C for the system air filter device(s) shall conform to the requirements given in Tables 160.3-A and 160.3-B.

II. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable.

A. The installer and rater shall perform the standard charge verification procedure as specified in Reference Residential Appendix Section RA3.2.2, or an approved alternative procedure as specified in Section RA1; or

B. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1, provided the system is of a type that can be verified using the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate verification procedure or approved alternatives in RA1. The ECC-Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1.

Exception 1 to Section 180.2(b)2AivbII: When the outdoor temperature is less than 55°F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to demonstrate compliance, the installer may elect to utilize the verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirements in Section 180.2(b)2AivbI.

Exception 2 to Section 180.2(b)2Aivb: The field verification and ECC-Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

v. **Altered space-heating system.** Altered or replacement space-heating systems shall not use electric resistance as the primary heat source.

Exception 1 to Section 180.2(b)2Av: Nonducted electric resistance space heating systems, if the existing space heating system is electric resistance.

Exception 2 to Section 180.2(b)2Av: Ducted electric resistance space heating systems, if the existing space heating system is electric resistance and a ducted space cooling system is not being replaced or installed.

Exception 3 to Section 180.2(b)2Av: Electric resistance space heating systems, if the existing space heating system is electric resistance in Climate Zone 6, 7, 8 or 15.

b. **Common use area space-conditioning systems.**

i. New or replacement space-conditioning systems or components other than new or replacement space-conditioning system ducts shall meet the requirements of Sections 170.2(c)1, 2 and 4, applicable to the systems or components being altered. For compliance with Section 170.2(c)4A, additional fan power adjustment credits are available as specified in Table 180.2-D.

TABLE 180.2-D—FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT

AIRFLOW	MULTI-ZONE VAV SYSTEMS[1] ≤ 5,000 cfm	MULTI-ZONE VAV SYSTEMS[1] > 5,000 AND ≤ 10,000 cfm	MULTI-ZONE VAV SYSTEMS[1] > 10,000 cfm	ALL OTHER FAN SYSTEMS ≤ 5,000 cfm	ALL OTHER FAN SYSTEMS > 5,000 AND ≤ 10,000 cfm	ALL OTHER FAN SYSTEMS > 10,000 cfm
Supply Fan System Additional Allowance	0.135	0.114	0.105	0.139	0.12	0.107
Supply Fan System Additional Allowance in Unit with Adapter Curb	0.033	0.033	0.043	0.000	0.000	0.000
Exhaust/Relief/Return/Transfer Fan System Additional Allowance	0.07	0.061	0.054	0.07	0.062	0.055
Exhaust/Relief/Return/Transfer Fan System Additional Allowance in Unit with Adapter Curb	0.016	0.017	0.022	0.000	0.000	0.000

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) for the definition of a multi-zone VAV system.

Exception 1 to Section 180.2(b)2Bi: Section 180.2(b)2Av does not apply to replacement of electric reheat of equivalent or lower capacity electric resistance space heaters, when natural gas is not available.

Exception 2 to Section 180.2(b)2Bi: Operable wall or roof openings that have been previously installed without interlock controls are exempt from complying with Section 170.2(c)4L.

Exception 3 to Section 180.2(b)2Bi: Section 170.2(c)4Ci is not applicable to systems that meet both of the following:

1. The system is not a single package air-cooled commercial unitary air conditioner or heat pump; and
2. The cooling capacity of the system is less than 54,000 Btu/h.

ii. **Altered duct systems.** When new or replacement space-conditioning system ducts are installed to serve an existing building, the new ducts shall meet the requirements of Section 160.3(c)2 and meet a or b below:

a. Reserved.

b. Entirely new or replacement duct systems installed as part of an alteration shall be leakage-tested in accordance with Section 160.2(c)2H. Entirely new or replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the building's existing duct system, including registers, grilles, boots, air handlers, coils, plenums and ducts, if the reused parts are accessible and can be sealed to prevent leakage.

Exception 1 to Section 180.2(b)2Biib: When it is not possible to achieve the duct leakage criteria in Section 180.2(b)2Biib, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified mechanical acceptance test technician utilizing the methods specified in Reference Nonresidential Appendix NA7.5.3

Exception 2 to Section 180.2(b)2Biib: Duct sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos, are not required to comply with Subsection 180.2(b)2Biib.

c. If the new ducts are an extension of an existing duct system, the combined new and existing duct system meets the criteria in Subsections I, II and III below. The duct system shall be sealed to a leakage rate not to exceed 15 percent of the nominal air handler airflow rate as confirmed through acceptance testing, in accordance with Reference Nonresidential Appendix NA7.5.3:

I. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and

II. The space-conditioning system serves less than 5,000 square feet of conditioned floor area; and

III. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:

A. Outdoors;

B. In a space directly under a roof that:

i. Has a *U*-factor greater than the *U*-factor of the ceiling, or if the roof does not meet the requirements of Section 170.2(a)1B, or

ii. Has fixed vents or openings to the outside or unconditioned spaces; or

C. In an unconditioned crawl space; or

D. In other unconditioned spaces.

iii. **Altered space-conditioning systems.** When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

a. For all altered units where the existing thermostat does not comply with the requirements for demand responsive controls specified in Section 110.12, the existing thermostat shall be replaced with a demand responsive thermostat that complies with Section 110.12. All newly installed space-conditioning systems requiring a thermostat shall be equipped with a demand responsive thermostat that complies with Section 110.12; and

b. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed, if the duct system meets the criteria of Section 120.4(g), as confirmed through acceptance testing, in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Nonresidential Appendix NA7.5.3, and conforming to the applicable leakage compliance criteria in Section 180.2(b)2Bii.

Exception 1 to Section 180.2(b)2Biiib: duct sealing. Buildings altered so that the duct system no longer meets the criteria of Section 170.2(c)4Ji are not required to comply with Subsection 180.2(b)2Biiib.

Exception 2 to Section 180.2(b)2Biiib: duct sealing. Duct systems that are documented to have been previously sealed as confirmed through acceptance testing in accordance with procedures in the Reference Nonresidential Appendix NA7.5.3 are not required to comply with Subsection 180.2(b)2Biiib.

Exception 3 to Section 180.2(b)2Biiib: duct sealing. Existing duct systems constructed, insulated or sealed with asbestos are not required to comply with the requirements of Subsection 180.2(b)2Biiib.

3. **Hot water systems**. Altered or replacement water-heating systems or components serving individual dwelling units shall meet the applicable requirements below:
   A. **Pipe insulation.** For newly installed piping and existing accessible piping, the insulation requirements of Section 160.4(e) shall be met.
   B. **Distribution system.** For recirculation distribution system serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in Reference Appendix RA4.4.9 shall be installed.
   C. **Water-heating system.** The water-heating system shall meet one of the following:
      i. A natural gas or propane water-heating system; or
      ii. A single heat pump water heater. The storage tank shall not be located outdoors and shall be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that either meets the requirements of Section 110.12(a) or has an ANSI/CTA-2045-B communication port; or
      iii. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher; or
      iv. If the existing water heater is an electric resistance water heater, a consumer electric water heater.
      v. A water-heating system determined by the Executive Director to use no more energy than the one specified in Sections 180.2(b)3Ci through iii above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the Executive Director to use no more energy than the one specified in Section 180.2(b)3Civ above.

4. **Lighting.**
   A. **Dwelling unit lighting.** The altered lighting system shall meet the lighting requirements of Section 160.5(a). The altered luminaires shall meet the luminaire efficacy requirements of Section 160.5(a). Where existing screw base sockets are present in ceiling-recessed luminaires, removal of these sockets is not required, provided that new JA8 compliant trim kits or lamps designed for use with recessed downlights or luminaires are installed.
   B. **Common use area—lighting, sign lighting, and electrical power distribution systems**.
      i. Spaces with lighting systems installed for the first time shall meet the applicable requirements of Sections 110.9, 160.5(b)1, 160.5(b)2, 160.5(b)3, 160.5(b)4, 160.5(c), 160.5(e), 170.2(b), and 170.2(e)1 through 170.2(e)6.
      ii. When the requirements of Section 160.5(b)4D are triggered by the addition of skylights to an existing building and the lighting system is not recircuited, the daylighting control need not meet the multi-level requirements in Section 160.5(b)4D.
      iii. New internally and externally illuminated signs shall meet the requirements of Sections 110.9, 160.5(d) and 170.2(e)7.
      iv. Altered indoor lighting systems. Alterations to indoor lighting systems that include 10 percent or more of the luminaires serving an enclosed space shall meet the requirements of a, b or c below:
         a. The alteration shall comply with the indoor lighting power requirements specified in Sections 170.2(e)1 through 4 and the lighting control requirements specified in Table 180.2-E; or
         b. The alteration shall not exceed 80 percent of the indoor lighting power requirements specified in Section 170.2(e)1 through 4, and shall comply with the lighting control requirements specified in Table 180.2-E; or
         c. The alteration shall be a one-for-one luminaire alteration within a building or tenant space of 5,000 square feet or less, the total wattage of the altered luminaires shall be at least 40 percent lower compared to their total prealteration wattage and the alteration shall comply with the lighting control requirements specified in Table 180.2-E.

      Alterations to indoor lighting systems shall not prevent the operation of existing, unaltered controls, and shall not alter controls to remove functions specified in Section 160.5(b)4.

      Alterations to lighting wiring are considered alterations to the lighting system. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display or decorative lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Sections 160.5(b)4Aiv.

      Exception 1 to Section 180.2(b)4Biv: Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded as specified in Section 170.2(e)2C.

      Exception 2 to Section 180.2(b)4Biv: Any enclosed space with only one luminaire.

      Exception 3 to Section 180.2(b)4Biv: Any alteration that would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

      Exception 4 to Section 180.2(b)4Biv: Acceptance testing requirements of Section 160.5(e) are not required for alterations where lighting controls are added to control 20 or fewer luminaires.

      Exception 5 to Section 180.2(b)4Biv: Any alteration limited to adding lighting controls or replacing lamps, ballasts or drivers.

Exception 6 to Section 180.2(b)4Biv: One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.

v. Alterations to existing outdoor lighting systems in a lighting application listed in Table 170.2-R or 170.2-S shall meet the applicable requirements of Sections 160.5(b)1, 160.5(b)2, 160.5(b)3, 160.5(c)1 and 160.5(e), and:

a. In alterations that increase the connected lighting load, the added or altered luminaires shall meet the applicable requirements of Section 160.5(c)2 and the requirements of Section 170.2(e)6 for general hardscape lighting or for the specific lighting applications containing the alterations; and

b. In alterations that do not increase the connected lighting load, where 10 percent or more of the existing luminaires are replaced in a general hardscape or a specific lighting application, the alterations shall meet the following requirements:

I. In parking lots and outdoor sales lots where the bottom of the luminaire is mounted 24 feet or less above the ground, the replacement luminaires shall comply with Section 160.5(c)2A and Section 160.5(c)2C;

II. For parking lots and outdoor sales lots where the bottom of the luminaire is mounted greater than 24 feet above the ground and for all other lighting applications, the replacement luminaires shall comply with Section 160.5(c)2A and either comply with Section 160.5(c)2B or be controlled by lighting control systems, including motion sensors, that automatically reduce lighting power by at least 40 percent in response to the area being vacated of occupants; and

Exception to Section 180.2(b)4Bvb: Alterations where fewer than five existing luminaires are replaced.

c. In alterations that do not increase the connected lighting load, where 50 percent or more of the existing luminaires are replaced in general hardscape or a specific application, the replacement luminaires shall meet the requirements of Subsection b above and the requirements of Section 170.2(e)6 for general hardscape lighting or specific lighting applications containing the alterations.

Exception 1 to Section 180.2(b)4Bvc: Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires are not required to comply with the lighting power allowances of Section 170.2(e)6.

Exception 2 to Section 180.2(b)4Bvc: Alterations where fewer than five existing luminaires are replaced.

Exception 3 to Section 180.2(b)4Bv: Acceptance testing requirements of Section 160.5(e) are not required for alterations where controls are added to 20 or fewer luminaires.

vi. Alterations to existing internally and externally illuminated signs that increase the connected lighting load, replace and rewire more than 50 percent of the ballasts, or relocate the sign to a different location on the same site or on a different site shall meet the requirements of Section 170.2(e)7.

Exception to Section 180.2(b)4Bvi: Replacement of parts of an existing sign, including replacing lamps, the sign face or ballasts, that do not require rewiring or that are done at a time other than when the sign is relocated, is not an alteration subject to the requirements of Section 180.2(b)4Bvi.

vii. Alterations to existing electrical power distribution systems shall meet the applicable requirements of the following sections:

a. Service electrical metering. New or replacement electrical service equipment shall meet the requirements of Section 160.6(a) applicable to the electrical power distribution system altered; and

b. Separation of electrical circuits for electrical energy monitoring. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 160.6(b); and

c. Voltage drop. For alterations of feeders and branch circuits where the alteration includes addition, modification or replacement of both feeders and branch circuits, the altered circuits shall meet the requirements of Section 160.6(c); and

Exception to Section 180.2(b)4Bviic: Voltage drop permitted by *California Electrical Code* Sections 647.4, 695.6 and 695.7.

d. Circuit controls for 120-volt receptacles and controlled receptacles. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 160.6(d).

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TABLE 180.2-E—CONTROL REQUIREMENTS FOR INDOOR LIGHTING SYSTEM ALTERATIONS FOR COMMON USE AREAS		
CONTROL SPECIFICATIONS	**PROJECTS COMPLYING WITH SECTION 180.2(B)4Biva**	**PROJECTS COMPLYING WITH SECTION 180.2(B)4Bivb OR 180.2(B)4Bivc**
Manual Area Controls 160.5(b)4Ai	Required	Required
Manual Area Controls 160.5(b)4Aii	Required	Required
Manual Area Controls 160.5(b)4Aiii	Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multilevel Area Controls 160.5(b)4B	Required	Not Required
Automatic Shut Off Controls 160.5(b)4Ci	Required	Required
Automatic Shut Off Controls 160.5(b)4Cii	Required	Required
Automatic Shut Off Controls 160.5(b)4Ciii	Required	Required
Automatic Shut Off Controls 160.5(b)4Civ	Required	Required
Automatic Shut Off Controls 160.5(b)4Cv	Required	Required
Automatic Shut Off Controls 160.5(b)4Cvi	Required	Required; except for 160.5(b)4Cvib
Daylight Responsive Controls 160.5(b)4D	Required	Not Required
Demand Responsive Controls 110.12(a) and 110.12(b)	Required	Not Required

5. **Mechanical ventilation and indoor air quality for dwelling units.** Alterations to existing buildings shall comply with Subsections A and B below as applicable. When field verification and diagnostic testing are required by Section 180.2(b)5, buildings with three habitable stories or fewer shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

   Exception to Section 180.2(b)5: A dwelling unit air leakage test is not required for alterations.

   A. **Entirely new or complete replacement ventilation systems.** Entirely new or complete replacement ventilation systems shall comply with all applicable requirements in Section 160.2(b)2. An entirely new or complete replacement ventilation system includes a new ventilation fan component and an entirely new duct system. An entirely new or complete replacement duct system is constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air filtration devices and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

      Exception: to Section 180.2(b)5A: The new or replacement ventilation type shall be supply, balanced, or the existing ventilation type being replaced.

   B. **Altered ventilation systems.** Altered ventilation system components or newly installed ventilation equipment serving the alteration shall comply with Section 160.2(b)2 as applicable subject to the requirements specified in Subsections i and ii below.

      i. **Whole-dwelling unit mechanical ventilation**.

         a. **Whole-dwelling unit ventilation strategy.** The altered ventilation system shall be supply, balanced, or the existing ventilation type being altered.

         b. **Whole-dwelling unit airflow**. If the whole-dwelling ventilation fan is altered or replaced, then one of the following Subsections 1 or 2 shall be used for compliance as applicable.

            1. Dwellings that were required by a previous building permit to comply with the whole-dwelling unit airflow requirements in Section 160.2(b)2, 120.1(b) or 150.0(o) shall meet or exceed the whole-dwelling unit mechanical ventilation airflow specified in Section 160.2(b)2Aiv or 160.2(b)2Av as confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Appendix RA3.7 or NA2.2.

2. Dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system to comply with Section 160.2(b)2, 120.1(b) or 150.0(o) shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 160.2(b)2Aiv or 160.2(b)2Av.

c. **Replacement ventilation fans.** Whole-dwelling unit replacement ventilation fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Sections 7.1 and 7.3. Additionally, when conformance to a specified whole-dwelling unit airflow rate is required for compliance, the replacement fans shall be rated at no less than the airflow rate required for compliance.

d. **Air filters**. If the air filtration device for a whole-dwelling unit ventilation system is altered or replaced, then one of the following Subsections 1 or 2 shall be used for compliance.

1. Dwellings that were required by a previous building permit to comply with the ventilation system air filtration requirements in Section 160.2(b)1, 120.1(b)1 or 150.0(m)12 shall comply with the air filtration requirements in Section 160.2(b)1.
2. Dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in Section 160.2(b)1, 120.1(b)1 or 150.0(m)12 shall not be required to comply with the air filtration requirements specified in Section 160.2(b)1.

ii. **Local mechanical exhaust**.

a. **Bathroom local mechanical exhaust**. Altered bathroom local mechanical exhaust systems shall comply with the applicable requirements specified in Section 160.0(b)2Avi.

b. **Kitchen local mechanical exhaust**. If the kitchen local ventilation fan is altered or replaced, then one of the following Subsections 1, 2 or 3 shall be used for compliance.

1. Dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in Section 160.0(b)2Avi, 120.1(b)2vi or 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 160.0(b)2Avi.
2. Dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater.
3. Dwellings that were not required to have a kitchen local ventilation exhaust system according to the conditions in either Subsection 1 or 2 above shall not be required to comply with the requirements of Section 160.0(b)2Avi.

c. **Replacement ventilation fans.** New or replacement local mechanical exhaust fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Section 7.1 and Title 24, Part 6, Section 160.0(b)2Avif. Additionally, when compliance with a specified exhaust airflow rate is required, the replacement fan shall be rated at no less than the airflow rate required for compliance.

(c) **Performance approach.** The altered component(s) and any newly installed equipment serving the alteration shall meet the applicable requirements of Subsections 1, 2 and 3 below. The energy budget for alterations is expressed in terms of long-term system cost (LSC) energy.

1. The altered components shall meet the applicable requirements of Sections 110.0 through 110.9, 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c), and 160.5. Entirely new or complete replacement mechanical ventilation systems as these terms are used in Section 180.2(b)5A shall comply with the requirements in Section 180.2(b)5A. Altered mechanical ventilation systems shall comply with the requirements of Sections 180.2(b)5B. Entirely new or complete replacement space-conditioning systems, and entirely new or complete replacement duct systems, as these terms are used in Sections 180.2(b)2Ai and 180.2(b)2Aiia, shall comply with the requirements of Sections 160.2(a)1 and 160.3(b)5L.
2. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements of Section 180.2(b). For components not being altered, the standard design shall be based on the unaltered existing conditions such that the standard and proposed designs for these components are identical. When the third-party verification option is specified, all components proposed for alteration for which the additional credit is taken must be verified by a certified ECC-Rater. <
3. The proposed design shall be based on the actual values of the altered components.

NOTES TO SECTION 180.2(c):

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the standard design altered component energy budget and must meet the requirements of Section 180.2(c)2.
2. The standard design shall assume the same geometry and orientation as the proposed design.
3. The “existing efficiency level” modeling rules, including situations where nameplate data is not available, are described in Section 10-109(c) and Section 10-116.

EXCEPTION 1 to Section 180.2(c): Any dual-glazed greenhouse or garden window installed as part of an alteration complies with the *U*-factor requirements in Section 170.2.

EXCEPTION 2 to Section 180.2(c): Where the space in the attic or rafter area is not large enough to accommodate the required *R*-value, the entire space shall be filled with insulation, provided such installation does not violate Section 1203.2 of Title 24, Part 2.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 180.3—REPAIRS

Repairs shall not increase the preexisting energy consumption of the repaired component, system or equipment.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

SECTION 180.4 —WHOLE BUILDING

Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for the entire building.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, *Public Resources Code*. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, *Public Resources Code*.

CALIFORNIA MECHANICAL CODE, CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 4, CHAPTER 6, DUCT SYSTEMS

TABLE P4-A ADOPTION TABLE

CODE SECTION		AGENCY
Adopt entire Chapter as amended (amended sections listed below)[1]		CEC
601.0		X
602.0		X
603.0		X
604.0		X
605.0		X

1. Adopted by reference for Occupancies A, B, E, F, H, I, L, M, R, S and U; see Sections 110.8(d)3, 120.4 and 150.0(m).

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APPENDIX

1-A

STANDARDS AND DOCUMENTS REFERENCED IN THE ENERGY CODE

The following documents are incorporated by reference to the extent they are referenced in the Energy Code.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE

AHRI 210/240-2023 (2020) Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment <

AHRI 310/380-2017 (Formerly ANSI/AHRI 310/380-2014) CSA C744-17)
Packaged terminal air-conditioners and heat pumps <

AHRI Standard 340/360 2022 (I-P)
2022 Standard for Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment <

ANSI/AHRI Standard 365 (I-P)
2009 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units <

ANSI/AHRI Standard 390-2021 (I-P)
2021 Standard for Performance Rating of Single Package Vertical Air-conditioners And Heat Pumps <

ANSI/AHRI Standard 400 (I-P)
2015 Standard for Performance Rating of Liquid to Liquid Heat Exchangers <

AHRI Standard 420-2023 (I-P) 2023 Standard for Performance Rating of Forced-circulation Free-delivery Unit Coolers

AHRI Standard 430-2020 (I-P) 2020 Standard for Performance Rating of Central Station Air-handling Unit Supply Fans <

AHRI Standard 440 (I-P) 2019 Standard for Performance Rating of Fan-coil Units <

ANSI/AHRI Standard 460 2005 Standard for Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers <

ANSI/AHRI Standard 550/590-2023
2023 Standard for Performance Rating of Water-Chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle <

AHRI Standard 560-2023 (I-P) 2023 Standard for Performance Rating of Water-cooled Lithium Bromide Absorption Water-chilling and Water-heating Packages

AHRI Standard 680 (I-P) 2017 Standard for Performance Rating of Residential Air Filter Equipment <

AHRI Standard 920 (I-P) with Addendum 1
2020 Standard for Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units <

AHRI Standard 1060-2023 (I-P) 2023 Standard for Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment <

AHRI Standard 1230-2023 (I-P) 2023 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air-conditioning and Heat Pump Equipment <

AHRI Standard 1240-2017 (R2023) (I-P)
2017 (R2023) Standard for Performance Rating of Active Chilled Beams

AHRI Standard 1250-2020 Standard for Performance Rating of Walk-in Coolers and Freezers

AHRI Standard 1360-2022 (I-P) 2022 Standard for Performance Rating of Computer and Data Processing Room Air Conditioners

Available from: Air-Conditioning, Heating and Refrigeration Institute
2311 Wilson Blvd., Suite 400
Arlington, VA 22203
(703) 524-8800

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AIR-CONDITIONING CONTRACTORS OF AMERICA

ANSI/ACCA 2 Manual J-2016 Manual J—Residential Load Calculation, Eighth Edition

ANSI/ACCA 2 Manual S 2023 Manual S—Residential Equipment Selection, Third Edition

Available from: Air-Conditioning Contractors of America, Inc.
2800 Shirlington Road, Suite 300
Arlington, VA 22206
(703) 575-4477
www.acca.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION

CANADIAN STANDARDS ASSOCIATION

WINDOW AND DOOR MANUFACTURERS ASSOCIATION

AAMA/WDMA/CSA 101/I.S.2/A440-22 North American Fenestration Standard/Specification for windows, doors, and skylights

Available from: AAMA
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173-4268
(847) 303-5664
www.aamanet.org

CSA
5060 Spectrum Way, Suite 100
Mississauga, ON, Canada L4W 5N6
(800) 463-6727
www.csagroup.org

WDMA
2025 M Street, NW, Suite 800
Washington, DC 20036-3309
(202) 367-1157
www.wdma.com

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

2024 TLVs and BEIs Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices

Available from: ACGIH
1330 Kemper Meadow Drive
Cincinnati, Ohio 45240
(513) 742-2020
www.acgih.org

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI/AMCA Standard 208-18 Calculation of the Fan Energy Index (2018)

ANSI/AMCA Standard 210-16/ASHRAE Standard 51-16
Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating

ANSI/AMCA Standard 220-21 Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating

ANSI/AMCA Standard 500-D-18 Laboratory Methods of Testing Dampers For Rating

ANSI/ASABE S640 JUL2017 (R2022)
Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)

ANSI/ASSP Z9.5-2022 Laboratory Ventilation

ANSI/CTA-2045-B: 2021 Modular Communications Interface for Energy Management

ANSI C82.6-2015 (R2020) American National Standard for Lamp Ballasts—Ballasts for High-Intensity Discharge Lamps—Methods of Measurement

> ANSI/NEMA WD 6-2021 Wiring Devices—Dimensional Specifications

ANSI Z21.40.4a-1998 (R2022)/CGA 2.94a-M98 (R2022)
Performance Testing and Rating of Gas-Fired, Air-Conditioning and Heat Pump Appliances

ANSI Z21.47-2021/CSA 2.3:21
Gas-Fired Central Furnaces

ANSI Z83.8-2016/CSA 2.6-2016 (R2021)
Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces (2016)

Available from: American National Standards Institute
25 West 43rd Street, 4th floor
New York, NY 10036
(212) 642-4900

ANSI/APSP/ICC-5-2011 American National Standard For Residential Inground Swimming Pools (2011 w/Addendum A)

Available from: Association of Pool & Spa Professionals
2111 Eisenhower Ave.
Alexandria, VA 22314
(703) 838-0083

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (NATIONAL PUBLICATIONS)

ASHRAE GUIDELINE 36-2021 High-Performance Sequences of Operation for HVAC Systems

ANSI/ASHRAE Standard 52.2-2017
Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ANSI/ASHRAE Standard 55-2023
Thermal Environment Conditions for Human Occupancy

ANSI/ASHRAE Standard 62.1-2022
Ventilation and Acceptable Indoor Air Quality

ANSI/ASHRAE Standard 62.2-2022
Ventilation and Acceptable Indoor Air Quality in Residential Buildings

ANSI/ASHRAE Standard 84-2020
Method of Testing Air-to-Air Heat/Energy Exchangers

ANSI/ASHRAE/IES Standards 90.1-2022
Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

ANSI/ASHRAE Standard 154-2022
Ventilation for Commercial Cooking Operations

ANSI/ASHRAE Standard 193-2010 (RA2014)
Method of Test for Determining the Airtightness of HVAC Equipment

ASHRAE Handbooks

2023 ASHRAE Handbook - HVAC Applications Inch-Pound Edition

2020 ASHRAE Handbook - HVAC Systems and Equipment I-P Edition

2021 ASHRAE Handbook - Fundamentals I-P Edition

Available from: American Society of Heating,
Refrigerating and Air-Conditioning Engineers
(ASHRAE)
1791 Tullie Circle N.E.
Atlanta, GA 30329
www.ashrae.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (REGIONAL PUBLICATION)

ASHRAE Climatic Data for Region X Arizona, California, Hawaii, Nevada, Publication SPCDX, 1982, ISBN #20002196 and Supplement, 1994, ISBN #20002596

Available from: Order Desk
Building News
10801 National Boulevard
Los Angeles, CA 90064
(800) 873-6397 or (310) 474-7771
www.bnibooks.com/

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME A17.1-2019/CSA B44:19 Safety Code for Elevators and Escalators

ASME A112.18.1-2018/CSA B125.1-18 Plumbing supply fittings

Available from: ASME
Two Park Avenue
New York, NY 10016-5990
(800) 843-2763
http://www.asme.org/

AMERICAN SOCIETY FOR TESTING AND MATERIALS/ASTM INTERNATIONAL

ASTM C55-17 Standard Specification for Concrete Building Brick (2017)

ASTM C177-19e1 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

ASTM C272/C272M-18 Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions

ASTM C335/C335M-23 Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation

ASTM C518-21 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C731-15 (2022) Standard Test Method for Extrudability, After Package Aging, of Latex Sealants

ASTM C732-17 (2022) Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants

ASTM C836/C836M-18 (2022) Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course

ASTM C1167-22 Standard Specification for Clay Roof Tiles

ASTM C1371-15 Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

ASTM C1492-22 Standard Specification for Concrete Roof Tile

ASTM C1549-16 (2022) Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

ASTM C1583/C1583M-20 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

ASTM D448-12 (2022) Standard Classification for Sizes of Aggregate for Road and Bridge Construction

ASTM D522/D522M-17 (2021) Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

ASTM D822/D822M-13 (2018) Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

ASTM D1003-21 Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics

ASTM D1653-13 (2021) Standard Test Methods for Water Vapor Transmission of Organic Coating Films

ASTM D1863/D1863M-05 (2018) Standard Specification for Mineral Aggregate Used on Built-Up Roofs

ASTM D2202-00 (2023) Standard Test Method for Slump of Sealants

ASTM D2370-16 (2021) Standard Test Method for Tensile Properties of Organic Coatings

ASTM D2824/D2824M-18 Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered and Fibered without Asbestos

ASTM D3468/D3468M-99 (2020) Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing

ASTM D3805/D3805M-16 (2023) Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings

ASTM D4798/D4798M-11 (2021) Standard Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)

ASTM D5870-22 Standard Practice for Calculating Property Retention Index of Plastics

ASTM D6083/D6083M-21 Standard Specification for Liquid- Applied Acrylic Coating Used in Roofing

ASTM D6694/D6694M-15 (2023) Standard Specification for Liquid- Applied Silicone Coating Used in Spray Polyurethane Foam Roofing Systems

ASTM E96/E96M-22ae1 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission of Materials

ASTM E283/E283M-19	Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	<
ASTM E408-13 (2019)	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques	<
ASTM E779-19	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	<
ASTM E903-20	Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres	<
ASTM E972-96 (2021)	Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight	<
ASTM E1175-87 (2022)	Standard Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere	<
ASTM E1677-23	Standard Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls	<
ASTM E1680-16 (2022)	Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems	<
ASTM E1918-21	Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field	<
ASTM E1980-11 (2019)	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces	<
ASTM E2178-21a	Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials	<
ASTM E2357-23a	Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies	<
ASTM E3087-18	Standard Test Method for Measuring Capture Efficiency of Domestic Range Hoods	<

Available from: ASTM International
100 Barr Harbor Drive West
Conshohocken, PA 19428-2959
(800) 262-1373 or (610) 832-9500

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS

AHAM HRH-2 Jan. 23, 2020	Residential Kitchen Range Hood Performance Test Procedures
AHAM RKRH-CPPG-2022	Residential Kitchen Range Hood Certification Program Procedural Guide (2022) Version 3.1

Available from: Association of Home Appliance Manufacturers
1111 19th Street, NW, Suite 402
Washington, DC 20036
(202) 872-5955
www.aham.org

CALIFORNIA HISTORICAL BUILDING CODE

2025 California Building Code
2025 California Electrical Code
2025 California Fire Code
2025 California Mechanical Code
2025 California Plumbing Code

Available from: California Building Standards Commission
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936
(916) 263-0916
www.bsc.ca.gov

CALIFORNIA ENERGY COMMISSION

Appliance Efficiency Regulations

Alternative Calculation Method (ACM) Manual

Available from: California Energy Commission
715 P Street
Sacramento, CA 95814
(916) 654-5106 or
(800) 772-3300 (in California)
www.energy.ca.gov/title24

CALIFORNIA DEPARTMENT OF CONSUMER AFFAIRS

Standards for Insulating Material

Available from: California Department of Consumer Affairs
Bureau of Household Goods and Services
4244 South Market Court, Suite D
Sacramento, California 95834-1243
(916) 999-2041

CERTIFYING ORGANIZATION

> CIE 13.3-1995 Method of Measuring and Specifying Colour Rendering Properties of Light Sources

>| | CIE 015-2018 Technical Report: Colorimetry, 4th Edition

COOLING TECHNOLOGY INSTITUTE

> CTI ATC-105 (19) Acceptance Test Code for Cooling Towers

> CTI ATC-105DS (18) Acceptance Test Code for Dry Fluid Coolers

> CTI ATC-105S (11) Acceptance Test Code for Closed-Circuit Cooling Towers

> CTI ATC-106 (11) Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers

> CTI STD-201 RS (17) Standard for the Certification of Water-Cooling Tower Thermal Performance

Available from: Cooling Technology Institute
| | 3845 Cypress Creek Parkway, Suite 420
Houston, Texas 77068
| | PO Box 681807
Houston, TX 77268
(281) 583-4087

COOL ROOF RATING COUNCIL

| | CRRC-1 (2023) Roof Product Rating Program Manual CRRC-1

Available from: Cool Roof Rating Council
2435 N. Lombard Street
Portland, OR 97217
| | (503) 606-8448
www.coolroofs.org

HOME VENTILATING INSTITUTE

> HVI Publication 915-2020 HVI Loudness Testing and Rating Procedure

> HVI Publication 916-2020 HVI Airflow Test Procedure

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ISO 13256-1:1998 (RA 2012)	Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps	<
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>	ANSI/NFRC 202-2023	Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence
>	ANSI/NFRC 203-2020 (R2023)	Procedure for Determining Visible Transmittance of Tubular Daylighting Devices
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>	UL 181A-2013 (R2021)	Standard for Safety Closure Systems for Use with Rigid Air Ducts
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>	UL 727-2018	Standard for Safety Oil-Fired Central Furnaces
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>	UL 1574-2004 (R2023)	Standard for Safety Track Lighting Systems
>	UL 1598-2021	Standard for Safety Luminaires

UL 1741-2021	Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources	<
ANSI/CAN/UL 1973-2022	Standard for Safety Batteries for Use in Stationary and Motive Auxiliary Power Applications	<
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APPENDIX
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ENERGY COMMISSION DOCUMENTS INCORPORATED BY REFERENCE IN THEIR ENTIRETY

The following documents published by the California Energy Commission are incorporated by reference in their entirety into the Energy Code.

Referenced appendices for the Building Energy Efficiency Standards for Residential and Nonresidential Buildings, including the Joint Appendices (JA), the Residential Appendices (RA), and Nonresidential Appendices (NA)

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HISTORY NOTE APPENDIX

2025 California Energy Code
California Code of Regulations, Title 24, Part 6

HISTORY:

For prior code history, see the History Note Appendix to the *California Energy Code,* 2022 Triennial Edition, effective January 1, 2023.

1. (CEC 01/24)—Repeal the 2022 adoption of the *California Energy Code*, CCR Title 24, Part 6 and adopt the 2025 *California Energy Code*. Approved by the California Building Standards Commission on December 17, 2024, filed with the Secretary of State on January 16, 2025, and effective on January 1, 2026.
2. Erratum to address miscellaneous corrections in Preface, Table 100.0-A—Application of Standards and Section 100.1—Definitions and Rules of Construction, and BESS capacity factors in Tables 140.10-B and 170.2-V, effective January 1, 2026.

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